REGIONAL RESOURCE RECOVERY

Sustainable Hauled Waste Management in Central Oregon

An analysis of alternatives to find the best solutions for all stakeholders.

Alternatives Analysis

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List of Acronyms and Abbreviations

CEC	Central Electric Cooperative
CF	cubic feet
CH4	methane
COB	City of Bend
CNG	compressed natural gas
CO2	carbon dioxide
DEQ	Department of Environmental Quality
EDCO	Economic Development of Central Oregon
EPA	Environmental Protection Agency
FOG	Fats, oils, and grease
GHG	greenhouse gas (emissions)
K	thousand
KW	kilowatt
M	million
MMBtu	Million British Thermal Units
N2O	nitrous oxide
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OHA	Oregon Health Authority
P3	public-private partnership
PE	Professional Engineer
PMP	Project Management Professional
RIN	Renewable Identification Number
RNG	renewable natural gas
RRR	Regional Resource Recovery
RV	recreational vehicle
SCFM	standard cubic feet per minute
SEP	Stakeholder Engagement Plan
TBL	triple bottom line
UGB	Urban Growth Boundary
USDA	United States Department of Agriculture
VS	volatile solids
WAS	waste activated sludge
WPCF	Wastewater Pollution Control Facility
WRF	water reclamation facility
WWTP	wastewater treatment plant

Executive Summary

The Regional Resource Recovery (RRR) Alternatives Analysis project evaluated different ways to manage high-strength hauled waste streams in Central Oregon, providing guidance for the City of Bend (COB) and regional stakeholders to make informed decisions about the best approach for managing brewery; fats, oils, and grease (FOG); septic; and portable toilet waste. Currently, in Central Oregon, millions of gallons of FOG, high-strength brewery, septic system, and portable toilet wastes are applied to agricultural land each year. This practice is a missed opportunity for resource recovery, requires a large amount of land, is not regulatorily sustainable, and does not align with the COB Council's goals of environmental stewardship.

Central Oregon is rapidly growing in population and with this growth comes more waste. As a result, the COB took the lead in investigating innovative alternatives for sustainable waste management. The RRR Alternatives Analysis project provides a roadmap for the future that benefits all stakeholders and aligns with the COB Community Climate Action Plan.

The RRR Alternatives Analysis was conducted by looking at seven different alternatives, and the results found that the construction of facilities to manage hauled waste streams is cost-effective and beneficial to the environment. Each of the alternatives had slight variations in feedstocks, location, digestion technologies, and product processing. The two main digestion technologies considered were (1) co-digestion, in which high-strength wastes were digested with municipal solids at a wastewater treatment plant (WWTP), and (2) stand-alone organics digestion, in which food-grade wastes are digested separately from municipal solids waste streams, such as septic waste, porta potty waste, and waste activated sludge (WAS).

A thorough stakeholder engagement process solicited input from a diverse group of participants through interviews, workshops, and surveys. Multiple organizations and individuals were invited to participate in the Stakeholder Committee and made significant contributions to the information provided in this report. The Stakeholder Committee included the following businesses and organizations below:

Municipalities
City of La Pine
City of Redmond
City of Bend
Deschutes County

Haulers
2-Springs Ranch/ George's Septic
Agri-Cycle
McDonald's Septic
Central Grease and Oil

Utilities
Cascade Natural Gas
Central Electric Cooperative
Sunriver Utilities

Brew waste
Central Oregon Brewer's Guild
Deschutes Brewery

Agencies
Oregon Department of Environmental Quality (DEQ)
Oregon Department of Agriculture
Oregon Health Authority (OHA)
Economic Development of Central Oregon (EDCO)

The key conclusions and alternative analysis are summarized below.

Key Conclusions from the Bend RRR Project

1. Based on the feedstocks identified, tested, and quantified, the three (3) highest-ranked alternatives are:
    a. Bend Water Reclamation Facility (WRF) co-digestion with 50% septage - the co-digestion of food waste, FOG, septic, waste-activated sludge (WAS), porta potty, brewery high-strength waste, and municipal solids at the Bend WRF to create electric energy.
    b. Bend WRF co-digestion with no septage- the co-digestion of food waste, FOG, brewery high-strength waste, and municipal solids at the Bend WRF to create electric energy.
    c. Renewable natural gas (RNG) at Knott Landfill - a stand-alone organics digestion facility at the Knott Landfill.
2. Many identified alternatives had a simple payback period of less than 20 years. Potential outside funding from grants and other incentives could reduce the simple payback period for the three lowest-cost alternatives to less than 10 years.
3. Based on stakeholder feedback, the current practice of hauling and land-applying brewery waste and FOG is not considered to be a viable long-term solution. A more sustainable and resilient solution for these and other waste streams is needed for Bend and its surrounding areas.
4. Hauled waste streams such as brewery waste and FOG have a high energy value that can be recovered in an anaerobic digestion process in the form of electricity or renewable natural gas (RNG).
5. The top-rated alternative could generate approximately 15,487 kilowatt hours (kWh) per day—enough energy to power more than 500 homes!
6. The stand-alone organics digestion facilities and co-digestion facilities alternatives could generate an annual net profit of up to $1 Million (M) and $1.4 M, respectively.
7. All alternatives produced Class A biosolids or composted soil. These products are great fertilizers and can be sold for profit.
8. For all digestion alternatives, food waste from the region was added as a digestion feedstock to allow for more energy resource recovery and the added benefit of diverting food waste from the landfill. Central Oregon could be a state leader in this area, as collecting energy from food waste has not yet been implemented by any Oregon municipality, although a few projects are in the design phase.
9. Further analysis of feedstocks is needed to refine the quantity and waste characteristics of feedstocks included in the current analysis. Examples of areas of refinement include low-strength brewery waste, food waste, and recreational vehicle (RV) waste.
10. The treatability and biogas availability study being completed by Oregon State University will help quantify potential gas volumes and quality produced through both regional co-digestion or organics-only digestion facilities.

11. Active engagement and input from the Bend RRR Stakeholder Advisory Committee (Stakeholder Committee) have been valuable, and the committee should be retained as part of continuing and follow-up investigations.
12. To fully implement a RRR program, a policy framework will be needed that can be implemented across regional boundaries. This framework should include pretreatment regulations, tipping fees (the fee for waste disposal), user fees, and associated program costs.
13. Public-private partnerships (P3) could help fund capital costs associated with a regional facility. For example, a partnership with Knott Landfill and Cascade Natural Gas could take advantage of combined feedstocks and additional methane capture.

Recommendations and Next Steps

Based on the conclusions presented, the project team makes the following recommendations and next steps:

1. The COB should complete a more detailed feasibility study either separately or in conjunction with the upcoming WRF Facilities Plan Update. The following alternatives are recommended to be carried forward for further evaluation in the detailed feasibility study:
    a. Bend WRF co-digestion with no septage
    b. Bend WRF co-digestion with 50% septage
    c. RNG at Knott Landfill
2. Consideration should be given in the detailed feasibility study (in Recommendation 1) for the following:
    a. Quantifying feedstocks available for low-strength brewery, food, and RV wastes.
    b. Investigating potential funding opportunities, including potential energy development incentive funding and P3. In particular, Alternative 3 (organics-only digestion with RNG at Knott Landfill) has a high potential for P3 to help fund capital costs associated with a regional facility.
3. The COB should continue to partner with Oregon State University to complete feedstock treatability studies to help refine and update energy production estimates for both Bend WRF co-digestion and organics-only waste processing facilities.
4. The COB should continue stakeholder engagement through all phases of the RRR Program.
5. The COB should begin working with neighboring communities, industries, and other stakeholders to develop a regional policy framework for the management of hauled waste. The policy can be utilized to incentivize the use of a RRR facility while providing economic benefits to businesses and rate payers. This policy framework should include a summary of targeted waste streams to be diverted to a regional facility and associated pretreatment requirements and regulations.

1 Introduction

Resource recovery and reuse are increasingly becoming essential components of community planning for sustainability and resilience. Concerns over water conservation and greenhouse gas (GHG) emissions are pushing cities to look at circular economies for both water and carbon. In addition, communities are seeking alternate forms of energy generation while reducing their overall carbon footprint. Waste products can become valuable resources.

Central Oregon is rapidly growing in population, and with this growth comes more waste. As a result, multiple hauled liquid waste streams are becoming a concern for the region. The City of Bend (COB) is taking the lead in investigating innovative alternatives for sustainable waste management. The Regional Resource Recovery (RRR) Alternatives Analysis project provides a roadmap for the future that benefits all stakeholders and aligns with the COB Community Climate Action Plan.

1.1 Purpose

The COB wants to find a long-term solution to managing regional hauled wastes that protects public health and the environment while providing resource recovery and economic benefits to the region. Identifying alternatives will give stakeholders options to consider for future feasibility studies and master planning activities, building a roadmap for a future that aligns with the COB Community Climate Action goals.

1.2 Background

Multiple hauled liquid waste streams are a growing concern for the COB and Central Oregon. Millions of gallons of fats, oils, and grease (FOG); high-strength brew waste; septic system; and portable toilet (porta potty) waste are applied to agricultural land each year. In particular, applying FOG waste to land is rare, and Central Oregon is the only location utilizing this practice in the state. There are concerns from state regulators about letting the land application of FOG continue due to impacts on soils. Land application of a lime stabilized slurry from septic systems and porta potty waste does provide nutrients to the soil, but there are missed opportunities for resource and revenue generation from these wastes. The current practice does not align with Bend Council goals of environmental stewardship.

As Central Oregon is one of the fastest-growing regions in the United States, application sites are diminishing as the volume of waste increases. Waste producers face the risk of local land application no longer being feasible, and trucking wastes out of the area seems to be the only alternative. Complaints of odors from land application have increased as the COB continues to expand into areas adjacent to application sites.

A diverse group of stakeholders, including surrounding cities, breweries, restaurants, and waste haulers, are interested in finding solutions for this regional challenge. A strategic analysis of alternatives for waste management helps determine the best course of action for handling the hauled wastes. Through collaboration and engagement, the hope is to develop one or more sustainable solutions that benefit all stakeholders and reduce costs to ratepayers, businesses, and industries while protecting public health and the environment—in addition to meeting the goals of the COB Community Climate Action Plan.

1.3 Project Goal and Drivers

The goal of the RRR project is to provide a strategic analysis of alternatives for handling multiple hauled waste streams in the community, guiding the COB and regional stakeholders in the best course of action, shifting from the concept of waste disposal to a feasible and more sustainable resource recovery and reuse alternative.

The COB is planning an update to the Water Reclamation Facility (WRF) Master Plan. The alternatives analysis is a component of master planning activities, as the preferred alternatives may require investments and upgrades to the WRF and/or COB property. Information gathered from the analysis will benefit COB operations and future development. The alternatives may also guide other municipalities and projects in Central Oregon.

Several main drivers have been leading the COB and stakeholders towards investigating options for resource recovery and reuse at this time. These drivers include significant environmental, economic, and social implications directly linked to a sustainable and resilient community. Key program drivers are as follows below.

Regulatory Sustainability

The current practice of FOG land application is uncommon because it makes a poor soil amendment, and studies find it has negative impacts on the soil's ability to retain nutrients. The land application is permitted by a Water Pollution Control Facility (WPCF) permit, but the practice has received the attention of the Oregon Department of Environmental Quality (DEQ) and the Governor’s office. Both are pushing the region to find better solutions for hauled wastes.

Effective Management of Brewery Waste

Breweries are an important part of the local economy and are woven into the Central Oregon culture. High-strength waste streams may be difficult to treat, costly to manage, and utilize valuable capacity at water reclamation facilities. Within the COB, Deschutes Brewery currently has a limit on discharges to the wastewater system, which requires side streaming and land application of a significant volume of food-grade wastes. The requirements of side streaming high-strength waste may limit industry growth due to costs and become a tenuous practice as application sites diminish and permitting requirements change.

FOG as a Renewable Resource

The presence of FOG in municipal wastewater is a growing concern for communities. FOG enters the sewage collection system from restaurants, homes, schools, adult care homes, coffee shops, dairies, and industrial food processing facilities. Accumulation of FOG in pipes can lead to blockages, backups, sanitary sewer overflows, and increased wastewater treatment costs. Therefore, FOG is a serious concern for the wastewater industry and the environment.

The COB estimates that over 4 million gallons of FOG are collected annually. While the COB has developed effective strategies for preventing FOG from entering the wastewater collections system, approximately 90% of the regional FOG waste is currently used as part of a slurry of other wastes applied to agricultural lands. This is an uncommon practice, as FOG does not make a good soil amendment; it reduces the hydro-conductivity of the soil, and the biological oxidation of high concentrations of FOG releases GHGs (carbon dioxide and methane) into the atmosphere. This practice does not align with the COB Community Climate Action Plan.

Alignment with the COB Community Climate Action Plan

COB's Council goals and its Community Climate Action Plan support alternative energy solutions that reduce the City's carbon footprint and GHG emissions. This plan includes a detailed road map on how the community can act now to reduce the impacts of climate change. One of the four climate sectors contributing to the bulk of Bend emissions is waste—including landfill disposal and wastewater treatment. This RRR project is a direct implementation of the COB Community Climate Action Plan by investigating and recommending investment in infrastructure upgrades to accommodate a higher level of waste recovery. Additionally, the Community Climate Action Plan is further accomplished beyond simply reducing carbon emissions, as there are additional co-benefits and goals (shown in Figure 1-1) that contribute to greater health and sustainability of the community.

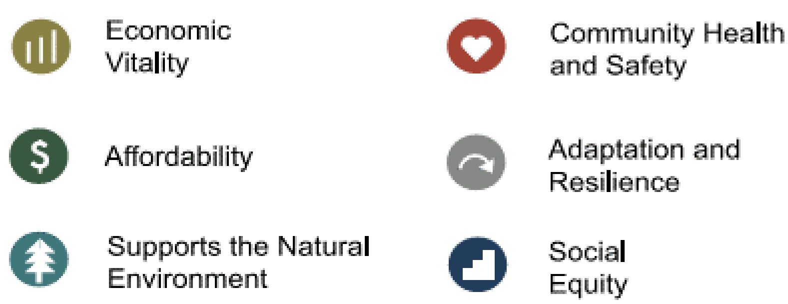

Figure 1-1: The co-benefits defined by Bend's Community Climate Action Plan

Affordable Cost of Service and Utility Rates

Affordability is at the top of the priorities for the COB. Innovative waste management may increase utility revenue and sustain utility rates over time. Tipping fees (the fee for waste disposal), renewable energy and compost generation, and a reduction in contractor expenses may provide additional revenue streams to fund future infrastructure upgrades and/or offset rising costs associated with treatment. In addition, findings may provide useful information for cost-of-service analysis and influence surcharge programs for high-strength users.

Optimized Land Use

As the regional population keeps growing, agricultural land is diminishing, further limiting the application of increasing volumes of waste. The waste products can only be applied for beneficial use on agricultural lands under specific site conditions and regulations, which further limits where and when they can be utilized. If these wastes must be hauled further out of town it will increase disposal and hauling costs, increasing greater GHG emissions. Additionally, as residential areas grow closer to application sites, there are concerns about odors.

1.4 Project Methodology

The COB engaged internal and external stakeholders in a comprehensive, collaborative, data-driven decision-making process, knowing this would increase the input of ideas, provide unique perspectives, and ultimately improve the outcome of the analysis. Understanding and implementing a Triple Bottom Line (TBL) approach as the basis for the analysis assured a balance of social, economic, and environmental drivers were considered.

1.4.1 Stakeholder Engagement

The RRR project team developed and followed a strategic stakeholder engagement plan that engaged stakeholders consistently and early through the alternatives analysis to build consensus and formulate recommendations for the COB. The engagement strategy included stakeholder identification, surveys, interviews, and workshops. Stakeholder engagement is summarized in detail in Section 2 of this report.

1.4.2 Triple Bottom Line Analysis

The alternative analysis used the Triple Bottom Line (TBL) methodology to evaluate alternatives. TBL is an accounting framework that comprehensively quantifies non-cost and cost factors. It was developed in the mid-1990s and is now used worldwide by businesses for a sustainability framework in making decisions. The project team used the TBL metric to include the three pillars of sustainable infrastructure in the analysis: contributions to environmental health, social well-being, and a fair economy.

The TBL evaluation criteria and weighting were developed in a workshop series with the project Stakeholder Advisory Committee (Stakeholder Committee) to balance project economic goals with social and environmental considerations. The alternatives analysis options were developed, scored, and ranked consistently by keeping stakeholders involved and having well-defined evaluation criteria. Hence, the results are fair and justifiable with proper prioritization of community climate action goals. Section 7 of the report covers the data and results of the TBL analysis in detail.

2 Stakeholder Engagement

The RRR project is intended to identify alternative management solutions for regional hauled wastes that will mitigate the negative impacts and risks of current practices while taking advantage of opportunities provided by other management options. With stakeholder input, the project team evaluated and made recommendations regarding:

- Increased resource recovery and reuse
- Increased revenue generation
- Decreased costs to ratepayers, governmental agencies, businesses, and industries
- Increased environmental benefits

The COB has had informal conversations with regional partners for the past several years. The RRR project team built on these discussions by directing meaningful dialogue and collaboration between stakeholders to encourage shared ownership and facilitate joint decision-making between the City and other regional governments, associations, and business partners.

2.1 Stakeholder Plan

A Stakeholder Register, attached in Appendix A, was developed with internal and external stakeholders involved in collecting, treating, disposing, and regulating hauled waste streams.

The Stakeholder Engagement Plan (SEP), in Appendix B.1, guided involvement and activities during the execution of the RRR project. As the RRR project team worked to develop and prioritize alternatives, the team recognized the importance of properly engaging and representing key stakeholders within the COB and the greater Central Oregon community. The SEP proposed strategies to make stakeholders aware of the project goals and have an opportunity to provide input in meaningful ways. Outreach efforts were designed to be proactive and utilize strategies that inform and engage key stakeholders.

The communication tools listed in Table 2-1 were developed and implemented as part of the RRR Alternative Analysis Project.

Table 2-1: Communication tools utilized in the alternatives analysis

COMMUNICATIONS TOOLS	AUDIENCE
Interviews	Affected key stakeholders
Email project updates	Stakeholder Register / target audience list, related business registrations, project email list, and others
Workshops	Stakeholder Advisory Committee
Website: https://www.bendoregon.gov/regional-resource	All interested parties
Fact sheet with Frequently Asked Questions	All interested parties
Talking points for COB staff, RRR project team, and elected officials	All interested parties

2.2 Summary of Stakeholder Interviews

The project team conducted 21 interviews with key affected stakeholders. Each stakeholder was requested to complete a questionnaire/survey prior to interviews that served as the basis for discussion. The surveys were utilized for interview questions and interviews were conducted in an open dialogue style. Survey questions were organized into five categories based on the stakeholder's relationship to hauled wastes: agencies, disposal facilities, utilities, businesses, and waste haulers. Survey questions and responses can be found in Appendix B.2 and Appendix B.3, respectively.

The following summarizes the highlights and themes from stakeholder interviews:

- There is a desire to protect agricultural lands.
- No new land application disposal areas have been developed for approximately 20 years, but demand is increasing rapidly. Suitable land disposal acreages are limited by size and proximity to developed areas.
- Do not land apply FOG waste. It is not beneficial to the soil and should not be considered a best management practice.
- There is a concern for ongoing business viability if regional facilities are implemented.
- Costs to discharge low-strength brewery waste to the COB system are too high, and regulations/costs are not applied equally to all.
- Most are willing to participate in a regional program if:
    - Costs are the same or lower than current, and other benefits are realized (such as environmental)
    - Costs and regulatory requirements are applied equally to all
    - Facilities are conveniently located

- Agencies are willing to participate by providing staff time to the cause, but no direct funding of the RRR program is currently in place.
- There are no notable regulatory changes.
- Knott Landfill will be closing in the next few years. Deschutes County is actively seeking a new solid waste management facility likely to be sited further east of Bend.
- Deschutes County is also actively pursuing a renewable natural gas (RNG) facility at the Knott Landfill site. There is potential to capture methane from the existing landfill as well as to develop an anaerobic digester utilizing various feedstocks from around the region.
    - The existing Knott Landfill is in very close proximity to the Trans-Canada natural gas pipeline, the regional natural gas distribution system, Bonneville Power Administration power lines, and Central Electric Cooperative (CEC) sub-station.
- Re-evaluate the existing commercial food waste program (and other bio-waste streams) to increase digester feedstock.
- There is a need for agencies and non-profit organizations to collaborate. Don't duplicate; coordinate.

2.3 Stakeholder Workshops

A total of 15 organizations and 19 individuals from the Stakeholder Register were invited to participate in the Stakeholder Committee, including the following:

Municipalities
City of La Pine
City of Redmond
City of Bend
Deschutes County

Haulers
2-Springs Ranch/George's Septic
Agri-Cycle
McDonald's Septic
Central Grease and Oil

Utilities
Cascade Natural Gas
Central Electric Cooperative
Sunriver Utilities

Brew waste
Central Oregon Brewer's Guild
Deschutes Brewery

Agencies
Oregon Department of Environmental Quality (DEQ)
Oregon Department of Agriculture
Oregon Health Authority (OHA)
Economic Development of Central Oregon (EDCO)

The Stakeholder Committee's roles and responsibilities included the following:

1. Participate in workshops.
2. Review information, data, and materials provided by the project team.
3. Complete a questionnaire/survey.
4. Schedule and participate in an interview with the project team.
5. Provide recommendations to the project team concerning waste stream reduction and resource recovery/reuse.

A series of workshops were utilized as a part of the effort to identify advancements in sustainable waste management practices throughout Central Oregon. The workshops were a four-part series to solicit input from key decision-makers and stakeholders in a collaborative project environment. Information from the workshops was utilized to inform the technical analysis. The below outlines the four workshops and results:

Stakeholder Workshop 1 – Introduction

Goal: Discuss areas of alignment, partnership opportunities, needs, opportunities, and concerns; review the strategic stakeholder engagement plan; and introduce the TBL criteria.

Workshop Result: Developed a list of important project outcomes for the stakeholders. The evaluation criteria for the technical analysis were established using this list.

Stakeholder Workshop 2 – Determine Alternatives and Evaluation Criteria

Goal: Develop an initial list of potential alternatives to be considered and establish TBL evaluation criteria and weighting.

Workshop Results: Established the TBL evaluation criteria and weightings.

Stakeholder Workshop 3 – Review Evaluation

Goal: Review alternative analysis results and feed results into the TBL criteria.

Workshop Results: Gained Stakeholder Committee input on the alternative siting and defined the TBL scoring rubric.

Stakeholder Workshop 4 – Final Recommendations

Goal: Review the results and establish the Stakeholder Committee's recommendations for sustainable waste management in Central Oregon.

Workshop Results: A final recommendation from the Stakeholder Committee on the alternative analysis for resource recovery in Central Oregon.

3 Data Collection

3.1 Current Practices

The COB's Industrial Pretreatment Program is responsible for source control of FOG and brewery waste. Data collection and management for regulatory requirements, cost-of-service analysis, and hauled waste inventory have been improved in recent years. Septic and portable toilet waste has not been closely monitored by the COB's pretreatment team as hauled wastes are not currently accepted by the COB's WRF. Agri-Cycle and the WRF track the comingled volumes of septic, portable toilet, and FOG waste for land application. The "slurry" typically consists of a 1:3 ratio of FOG to portable toilet/septic waste. Thus, the volumes may be extrapolated by removing FOG. Other quantitative data include stakeholder discussions, anecdotal information, and regulatory reports.

3.2 Data Collection Approach

Qualitative data refers to non-numerical research conducted to gather information around the concepts of hauled wastes, individual thoughts, and experiences. The stakeholder engagement process utilized interviews, workshops, surveys, and observations to gather the appropriate data to support the TBL methodology and anecdotal information to support the quantitative data analysis.

Quantitative volumetric data analysis involved an inventory of all waste streams. Primary data sources included the 2020 Beverage Waste Management Report from the COB's Industrial Pretreatment Program, SwiftComply FOG management data, Agri-Cycle and hauler tracking logs, and WRF sampling and volume data. Secondary data sources included Environmental Protection Agency (EPA) online information about FOG and brewery waste and a DEQ food waste listening session.

Feedstock characteristic data was needed to complete the alternatives analysis. The COB developed a sampling plan, collected samples, and completed lab analysis for various feedstocks. Literature values were used to fill any gaps in characteristic data.

3.3 Inventory of Hauled Wastes

The project team conducted an inventory of hauled wastes and separated them into unique categories. Understanding volumes of individual waste streams is important for cost analysis and feedstock supply. Separation of volumes of food-grade wastes from domestic and/or sanitary waste is important in making evaluations. Handling, disposal, and permitting requirements are different for food-grade waste and may influence the value of outcomes.

3.3.1 Organics

Brewery Waste – Due to concerns about the design capacity and loading to the WRF, the City's Industrial Pretreatment Program embarked on a 2-year beverage waste management study to understand the concentrations and volumes of brewery wastes entering the COB's collection system and hauled wastes for agricultural application. The study, completed in 2020, provided a clear picture of this potential feedstock.

FOG – The City's Industrial Pretreatment Program utilizes Swift Comply, a cloud-based data management system, to track grease trap cleanings and frequencies. This information is used to estimate volumes of FOG waste delivered to Agri-Cycle for land application.

Food Waste – Knott Landfill tracks food wastes used in composting. Secondary data was gathered through the DEQ food waste listening session that included volume information from other cities in Oregon.

3.3.2 Regulated Feedstocks

WRF Primary and Secondary Sludge – The WRF had data available for volumes through plant operations and biosolids management.

Septic Waste, Portable Toilet, Camper/Recreational Vehicle (RV) waste, and Waste Activated Sludge (WAS) – Septic, portable toilet wastes, and WAS volumes from treatment plants outside of Bend are tracked by haulers and waste disposal facilities. FOG volumes are from waste disposal facilities (Agri-Cycle, Two Springs, and Southwest Water) documentation. However, the COB is unclear about the volume of private unregulated RV dumps. At least 12 private facilities have little or no disposal tracking or volumes. The City of Redmond has a public RV Dump Station and keeps track of volume data.

3.3.3 Summary of Loading Projections

Table 3-1 summarizes the feedstock volumetric inventory and characteristic data for the Central Oregon region. Data represents the feedstocks currently collected as hauled waste. Possible additional feedstocks generated in Central Oregon, but not currently hauled as waste, were not inventoried as part of the study.

The "Grease" line item below is concentrated grease (about 50% grease solids), while the "FOG" line item is regular FOG (about 12% solids, which is more like FOG-contaminated wastewater). The concentrated waste is separated because it will produce more gas per unit of volume and consume more digester volatile solids capacity per unit of volume.

Table 3-1: Summary of data collection and review

Feedstock	Units	Amount	Volatile Solids Load (lbs/month)	Volatile Solids Load (lbs/day)	Hydraulic Load (gal/month)	Hydraulic Load (gal/day)
FOG	gal/month	98,075	93,246	3,108	98,075	3,269
Grease	gal/month	1,625	6,627	221	1,625	54
Food Waste	tons/month	55	26,632	888	48,247	1,608
Brewery Waste	gal/month	312,000	85,273	2,842	312,000	10,400
Septage and Porta Potty Waste	gal/month	667,826	67,416	2,248	667,826	22,260
Hauled WAS	gal/month	70,925	12,774	426	141,849	4,728
Total			**291,968**	**9,733**	**1,269,622**	**42,319**

4 Technology Preliminary Screening

The alternatives analysis started with a technology pre-screening. Technologies were divided into six categories:

1. Feedstock collection
2. Pre-treatment/receiving station
3. Digestion technologies
4. Digester gas processing
5. Recycled water
6. Digester solids processing

Figure 4-1 illustrates these technologies. Feedstock collection strategies were outside the scope of the alternatives analysis; the project team recommends feedstock collection strategies be further evaluated in the feasibility study.

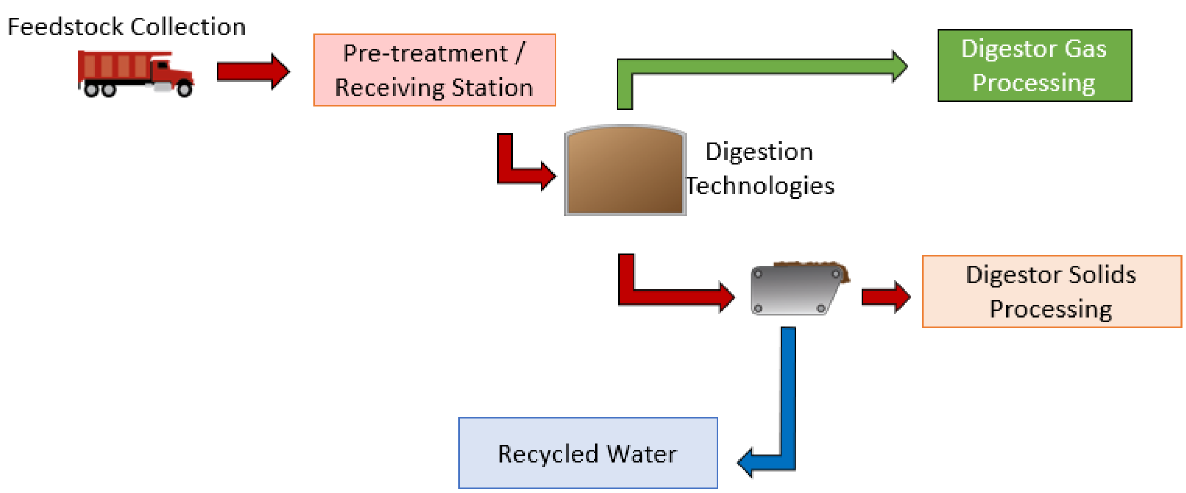

Figure 4-1: Process flow diagram showing the technology categories used for pre-screening

This section of the report includes a description of the technologies identified as possible alternatives. These technologies were evaluated because of their applicability to the waste streams and prior use in other digestion or co-digestion facilities. Some technologies were determined to be feasible, while others were not recommended for the RRR project.

4.1 Pretreatment/Receiving Station

A feedstock receiving facility will be necessary to receive the co-digestion feedstock. Typical feedstock-receiving facilities include the following elements:

- Feedstock receiving tank to hold multiple deliveries of feedstock

- Feedstock receiving pump to transfer the feedstock from the hauling vehicle to the receiving tank
- Screening or grinding equipment to remove debris from the feedstock
- Mixing system to homogenize the content of the receiving tank and prevent solids from accumulating at the bottom of the tank
- Feedstock feed pumps to transfer feedstock from the receiving tank to the digesters
- A small odor control unit to treat foul odors
- An interface that allows haulers to initiate material transfers from their hauling vehicle to the receiving tank and log the amount of material delivered

The receiving facility should be located in a space that will be relatively easy for feedstock haulers to access and is relatively close to the digesters.

4.2 Digestion Technologies

Three possible digestion technologies were evaluated, with mesophilic digestion being the recommended option.

Dry Digestion

Dry digestion was eliminated as a potential technology due to the nature of the feedstocks to be received and processed at the organics digestion facility. Dry digestion is a high-solids process, with total solids content typically greater than 15%. The solids content of the feedstocks anticipated to be received is anticipated to be 3% or less; therefore, dry digestion would not be a suitable technology.

Thermophilic Digestion

Thermophilic digestion is the anaerobic digestion of waste at a temperature of approximately 122°F to 140°F. The advantage of thermophilic digestion is that the fermentation process occurs more rapidly than in a mesophilic digester, producing more biogas than the mesophilic digestion process. If EPA-established time and temperature criteria are met, thermophilic digestion can also produce Class A biosolids.

The primary reason that thermophilic digestion was not considered in the alternatives analysis is that thermophilic digestion is a more complicated process to operate and maintain, and there is an increased amount of energy required to maintain the digester at a higher temperature. Also, the advantage of producing Class A biosolids can be accomplished post-digestion with other methods such as composting.

Mesophilic Digestion

Mesophilic digestion is the anaerobic digestion of waste at a temperature of approximately 98°F to 100°F. Typically, mesophilic digestion is a more stable process than thermophilic digestion. It also has the advantage of requiring less energy to maintain the digester temperature. Mesophilic digestion is the most common anaerobic digestion technology and is used widely in municipal and private business applications to stabilize biological solids waste streams.

Mesophilic digestion was selected as the most appropriate anaerobic digestion technology for this analysis, given the nature of the feedstocks, its common use in co-digestion and digestion applications, and its relatively lower energy requirements compared to thermophilic digestion.

4.3 Digester Gas Processing

The pre-screening of digester gas processing equipment narrowed down possible electricity generation technologies to the following two technologies:

- Reciprocating combustion cogeneration engines
- Microturbine technology

The gas conditioning treatment varies with use of energy. Alternatives that produce electric energy require gas conditioning for moisture, hydrogen sulfide, and siloxane treatment. RNG alternatives require the excess treatment of carbon dioxide. Below is a summary of the digester gas processing pre-screening analysis.

Gas Conditioning

Gas conditioning is necessary to remove impurities from the biogas stream before the biogas is utilized in microturbine, cogeneration, or RNG production systems. Gas conditioning systems typically target the removal of moisture, hydrogen sulfide, siloxanes, and/or carbon dioxide, depending on the ultimate use of the biogas. For the alternatives considered in this analysis, moisture, hydrogen sulfide, and siloxane treatment are recommended for utilization of the biogas in microturbine and cogeneration systems. Carbon dioxide removal is recommended for the production of RNG.

Air Pollution Control

Each alternative must include provisions for controlling biogas emissions to the environment. For this analysis, it was assumed that a biogas flare would be provided to combust any biogas that cannot be utilized in the microturbine, cogeneration, or RNG production systems. This may be necessary when the systems are off-line for maintenance or repair. Flaring the biogas prevents methane, a potent GHG, from being released into the atmosphere, and is an important air pollution control measure.

Digester Gas Utilization – Electricity Generation

Reciprocating combustion cogeneration engines generate electricity and heat through the combustion of biogas or other fuel. Generally, cogeneration engines are typically 65% to 80% efficient. Biogas must be conditioned to remove hydrogen sulfide and siloxanes from the biogas stream before being used as fuel for the engine. Heat is recovered from the engine jacket water and exhaust for other uses, such as heating a hot water loop that can be used to heat the digester. Cogeneration has been a popular technology at wastewater treatment plants for many years. Reciprocating engines were determined to be an appropriate technology to include in the alternatives analysis.

Microturbine technology involves fuel combustion under pressure, producing gas that expands through a turbine to produce electricity. Microturbines are suitable for facilities producing lower volumes of biogas, as they can be sized for electricity production as low as 30 kilowatts (kW). Microturbines also typically have less nitrous oxide and sulfur oxide emissions than combustion engines. Like combustion engines, heat may also be recovered from the exhaust of the microturbine and utilized for a hot water loop. For these reasons, microturbines were determined to be an appropriate technology to include in the alternatives analysis.

Gas turbine technology is similar to microturbine technology but is most suitable for large capacity generation (1 megawatt or larger). A gas turbine is not a suitable technology for this alternatives analysis because the volume of biogas that would be produced is not great enough to fuel the gas turbine; therefore, this technology was eliminated from the detailed alternatives analysis.

Fuel cell energy generation involves the thermochemical reaction of biogas with the cell to produce heat and electrical currents. Fuel cells do not utilize combustion technology; therefore, the emissions of nitrous oxides and sulfur oxides are minimal. Compared to other technologies, the cost per kW generated by a fuel cell is high, in part because the fuel cell stack must be replaced regularly when using biogas as a fuel due to the build-up of contaminants within the stack, even with appropriate biogas conditioning. This is a significant maintenance cost. Additionally, fuel cells are most suitable for large capacity generation. As a result, this technology was eliminated from the detailed alternatives analysis.

Digester Gas Utilization – RNG

Pipeline injection is the compression of RNG for injection directly into a natural gas pipeline for use within the natural gas distribution system. Injection of RNG requires more gas conditioning compared to the utilization of biogas within an engine, including the removal of carbon dioxide from the biogas stream. RNG was assessed in alternatives where the site location was in close proximity to natural gas pipeline.

Beneficial use of compressed natural gas (CNG) for on-site vehicle fuel use requires similar gas conditioning and compression as that required for pipeline injection. This technology also requires the utility to use a fleet of CNG vehicles. If the utility does not already have a CNG fleet, it could be costly to purchase new vehicles. CNG fueling can also be limiting for some utilities because it requires that all fleet vehicles are fueled at a central location. On-site vehicle fuel use was eliminated as a technology, given the lack of a CNG fleet.

4.4 Recycled Water

A package membrane bioreactor was utilized for the basis of analysis as the technology to treat liquid waste streams (primarily centrate produced from the biosolids dewatering process) that would be generated at the organics digestion facility. The bioreactor includes processes for influent waste stream screening, nitrification, denitrification, and membrane clarification to provide sufficient treatment for the reuse of the effluent as recycled water.

4.5 Digester Solids Processing

The project team evaluated several technologies for digester solids processing. In summary, the following technologies were utilized in the alternatives analysis:

- Centrifuges for solids dewatering
- Solids drying beds for solids drying
- A three-phase aerated static pile process for composting

Solids Dewatering

Several technologies exist for dewatering digested solids, including belt presses, screw presses, and centrifuges. Typically, centrifuges can produce the highest dewatered total solids concentration (in the range of 20% to 25% or more). Centrifuges are an established technology and a popular choice for dewatering anaerobically digested solids. For these reasons, the centrifuge was selected as the technology to use in the alternative analysis.

Solids Drying and Land Application

The COB currently dries dewatered solids in drying beds to create Class A biosolids. After the solids have dried, agricultural partners remove them from the WRF site and then apply the biosolids to agricultural land. This analysis assumed that the status quo for solids drying would continue and was selected as the preferred biosolids management option for alternatives sited at the Bend WRF.

Composting

For the stand-alone organic digestion facilities, the produced biosolids would be composted through a three-phase aerated static pile process following dewatering. Composting was selected for the stand-alone organic digestion alternatives because the solids will not contain any human waste (e.g., septage or sewage) and the compost product is suitable for resale with a wider variety of uses compared to biosolids. Approximately 14,600 square feet of space is required for the composting process, which is anticipated to take approximately 8 weeks. Mixing equipment to incorporate wood and green waste organic bulking material and screening equipment to remove the bulking material after composting are also required as part of this process.

5 Facility Location

Multiple locations throughout Central Oregon were evaluated for the siting of each alternative. Locating a facility on a site with existing infrastructure, such as a wastewater treatment facility or landfill, is very desirable. The following considerations were factored into siting:

- Distance from the bulk of waste streams
- Hauling costs
- Energy costs
- Stakeholder input
- Proximity to natural gas distribution infrastructure
- Proximity to electrical grid and/or facility with large energy usage
- Additional methane capture and/or co-digestion of feedstocks
- Existing composting and/or solids drying facilities

5.1 Alternative sites

Three potential sites were considered for the alternatives analysis: the COB WRF, Knott Landfill, and Redmond RV Dump Station.

Bend WRF

The WRF is an obvious candidate due to the existing water treatment, digesters, solids dewatering, and drying infrastructure. The site has a large amount of available land that could be expanded to accommodate expansion. There are no natural gas lines near the site, but there is an electrical grid. Additionally, the WRF is a large consumer of electricity, and co-generated energy could be utilized onsite, and heat produced can be recycled for building heating and process use.

Knott Landfill

During stakeholder interviews, the team found that Deschutes County Solid Waste was starting a landfill gas capture project at the Knott Landfill. This project would allow a partnership with a digestion facility to increase the RNG produced. The gas conditioning and compression infrastructure could be shared between the two projects to reduce capital investment. The landfill is situated perfectly for RNG, as the TransCanada and local gas distribution lines both cross the property. The site was also closest to the population center compared to the other sites, resulting in the lowest GHGs from hauling. On the downside, Knott Landfill is land limited, and the COB has grown around the site. A school and residential area are located across the street.

Deschutes County Solid Waste is in the process of siting a new landfill. The new location will be further east of the COB. Due to the hauling distances and lack of existing facilities and utilities, the new landfill site was eliminated from the alternatives analysis.

Redmond RV Dump Station

Redmond is geographically the hub of Central Oregon due to its location. It is the second most populous center in the region and is located close to the bulk of agricultural lands for land application. The City of Redmond has just begun a project to transition from conventional wastewater treatment to wetland treatment. Due to the nature of a wetland treatment process, the city will not have solids digestion or dewatering at the site. Additionally, the treatment plant is north of town, far from the population center of the region. Therefore, the City of Redmond's treatment facility location was eliminated as an alternative.

The City of Redmond owns property at the Redmond RV Dump Station near the Redmond Airport. This property is south of town and is easy to access from most population centers of the region. Additionally, Deschutes County Solid Waste owns property near the Redmond RV Dump Station and expressed interest in partnering for composting. The dump station is located within Redmond city limits, allowing the sewer to be utilized for any wastewater treatment and thereby reducing the capital needed for wastewater treatment onsite. For the Redmond RV Dump Station alternative, it is assumed that digestion occurs at the dump station and solids processing occurs at the Deschutes County Solids Waste property.

5.2 Hauling Distances

Hauling distances impact carbon emissions and the economic viability of the facility. The location of the facility must minimize hauling distances as much as possible to help incentivize private companies to utilize the infrastructure. A map of hauling contours can be found in Appendix C. This map visually shows the hauling distances and carbon emissions based on the siting location. Table 5-1 includes a summary of hauling distances compared to the feedstock source location.

Table 5-1: Summary of hauling distances

Criteria	Alternative Location			Units
	Bend WRF	Knott Landfill	Redmond	
Total Vehicle Miles	2,438	1,387	3,445	miles per month
Total CO_2 Emissions	2,954	1,680	4,175	kg CO_2 per month
Total Hauling Cost	5,691	3,667	6,792	$ per month

6 Alternatives Analysis

This section describes the alternatives considered for the project. The design criteria, facility layout, and cost summary are provided for each alternative.

6.1 Selection of Alternatives and Methodology

The alternatives were selected through an iterative process involving project stakeholders. Four alternatives were initially developed by the project team and presented at Stakeholder Workshop No. 2. The alternatives included:

- Alternative 1 – Status Quo
- Alternative 2 – Organics-Only Digestion with Microturbine
- Alternative 3 – Organics Only Digestion with RNG
- Alternative 4 – Co-digestion of WAS, FOG, and Food and Brewery Waste with Cogeneration at Bend WRF

Following Workshop No. 2, the four alternatives were evaluated based on capital cost, operating cost, and anticipated product revenue. The preliminary results were presented at Stakeholder Workshop No. 3. During Stakeholder Workshop No. 3, feedback from the stakeholders was received regarding specific project locations for each of the alternatives, and three additional alternatives were added to the analysis based on suggestions from stakeholders. The final list of alternatives is listed below:

- Alternative 1 – Status Quo
- Alternative 2 – Organics Only Digestion with Microturbine at Knott Landfill
- Alternative 3 – Organics Only Digestion with RNG at Knott Landfill
- Alternative 4 – Co-digestion of WAS, FOG, and Food and Brewery Waste with Cogeneration at Bend WRF
- Alternative 5 – Co-digestion of WAS, FOG, Food, and Brewery Waste, and Septage with Cogeneration at Bend WRF
- Alternative 6 – Organics Only Digestion with Cogeneration at Redmond RV Dump Station
- Alternative 7 – Organics Only Digestion at Knott Landfill and Hauled Digestate to Bend WRF

Each alternative has been developed to establish the following factors:

- Design criteria
- Capital costs
- Operation and maintenance costs
- Revenue

To establish the design criteria for each alternative, the facilities and equipment were sized for the anticipated volume of feedstock delivery, biogas production, residual solids production, and recycled water production. The following assumptions were used when determining the design criteria:

- Organics only digesters were sized for a maximum volatile solids loading of 0.6 pounds per cubic foot per day (lb/cf/d) and a maximum hydraulic residence time of 10 days.
- Co-digestion digesters were sized for a maximum volatile solids loading of 0.2 lb/cf/d and a maximum hydraulic residence time of 15 days.
- Digester gas was assumed to be produced at a rate of 15 cubic feet per pound of volatile solids destroyed within the digester.
- Volatile solids reduction within the digester was assumed to be 90% for FOG and grease feedstocks, 74% for food feedstocks, 89% for brewery waste feedstocks, and 50% for septage feedstocks.
- The solids content within the digester was assumed to be 3%.
- Residual solids were assumed to be dewatered to a solids concentration of 20% and composted to a solids concentration of 50%.
- The project team assumed that the feedstock supply available for digestion would grow at the same rate as the Deschutes County population. The Portland State University Population Research Center Coordinated Population Forecast for Deschutes County, the county's urban growth boundaries (UGBs), and area outside the UGB from 2015 to 2065 were used to select the appropriate population growth rate. A rate of 2.3% growth per year was selected.

The project team solicited quotes from equipment suppliers for the major equipment required for each alternative to develop the capital and operating costs. Manufacturers also provided operations and maintenance (O&M) cost information, which was incorporated into the analysis.

Beneficial products can be produced from the treatment of hauled waste, including natural gas, electricity, heat, and recycled water. These potential benefits were considered and evaluated for each of the alternatives, including:

- Revenue from the sale of RNG
- Revenue from tipping fees paid by feedstock haulers
- Revenue from the sale of solids products (i.e., compost)
- Costs avoided for supplemental heat for digester heating

To estimate the value of the products, the following assumption was made:

- Natural gas value is assumed to be $4.03/MMBtu, to be consistent with the value used by Knott Landfill for the evaluation of an RNG production facility in partnership with Cascade Natural Gas. Labor cost is assumed to be $46.15/hour based on information received from the COB.

A simple payback analysis was performed to compare the alternatives. The simple payback analysis calculates the number of years of operation required for the project to pay for itself. For this analysis, the simple payback is the number of years of operation required for the value of the products to pay for the construction of the organics digestion facility. The results of the simple payback analysis are summarized in Appendix D. The following costs and assumptions were used in the preparation of the analysis:

- Capital cost of the facilities required for each alternative
- Operation costs for the equipment and processes (i.e., labor, chemical, power)
- Value of offset energy costs from the production of electricity
- Electricity cost is assumed to be $0.057/kWh based on Central Electric Cooperative industrial rates

In addition to the simple payback for each of the alternatives, social and environmental factors were also considered; these factors are described in the TBL analysis in Section 7.

6.2 Alternatives Descriptions

This section includes a description of each of the seven alternatives.

6.2.1 Analysis of Alternative 1 – Status Quo

Alternative 1 would continue the current practices of hauled waste disposal at various facilities, which do not include the reduction or recovery of any resources. Organic hauled waste, FOG, septage, and food and brewery waste would continue to be hauled, lime-stabilized, and applied to agricultural land as a soil amendment as shown in Figure 6-1.

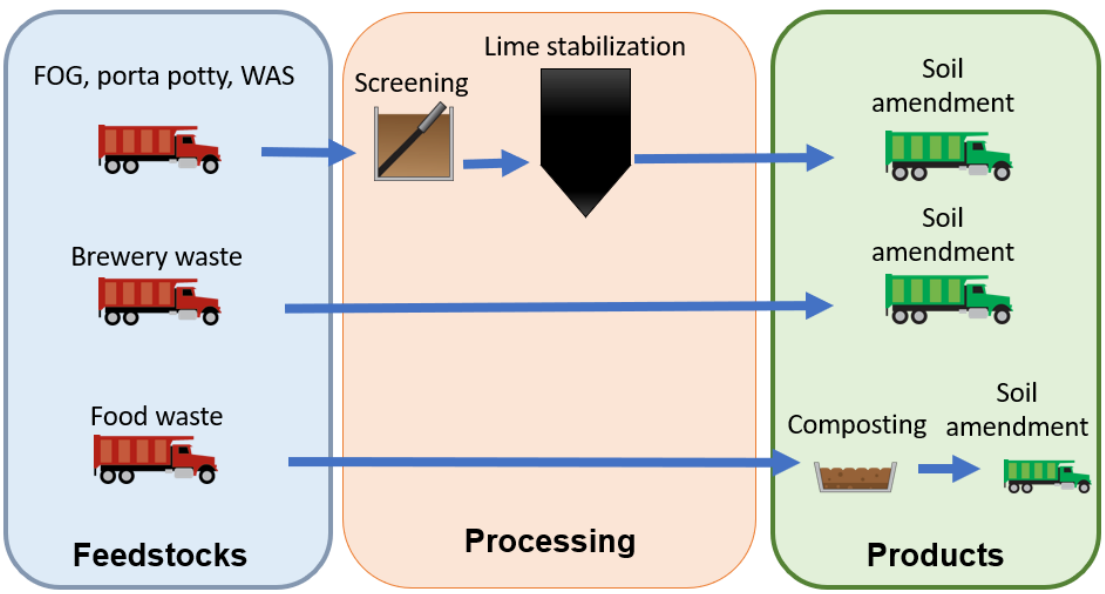

Figure 6-1: Alternative 1 – Status Quo process flow diagram

6.2.2 Analysis of Alternative 2 – Organics Only Digestion with Microturbine at Knott Landfill

Alternative 2 includes hauling organic waste feedstocks, including FOG, food, and brewery waste, to a new organics digestion facility located at Knott Landfill. The primary components of the facility include the following:

- Feedstock receiving station
- Steel digester
- Biogas treatment system
- Microturbine power generation system
- Centrifuge solids dewatering system
- Composting system
- Recycled water treatment system

Table 6-1 includes the key design criteria for Alternative 2.

Table 6-1: Alternative 2 - Design criteria

Parameter	Value	Unit
Organic Waste Volume	15,332	gallons per day
Organic Waste Volatile Solids	7,059	pounds per day
Target Hydraulic Retention Time	10	days
Receiving Tank Volume	15,000	gallons
Digester Volume[(a)]	250,000	gallons
Compost Production[(b)], start-up	550	wet tons per year at 50% solids
Compost Production[(b)], future	867	wet tons per year at 50% solids
Gas Production[(c)], start-up	64	standard cubic feet per minute
Gas Production[(c)], future	101	standard cubic feet per minute
Gas Production[(c)], peak	152	standard cubic feet per minute
Power Production, start-up	1,616,220	kWh/year

(a) Assumed growth factor of 2.3 percent and planning period of 20 years.

(b) Assumed FOG/grease/food waste/brewery waste volatile solids reduction of 90%/90%/74%/89%, respectively.

(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.

A diagram illustrating the components of the facility is included in Figure 6-2.

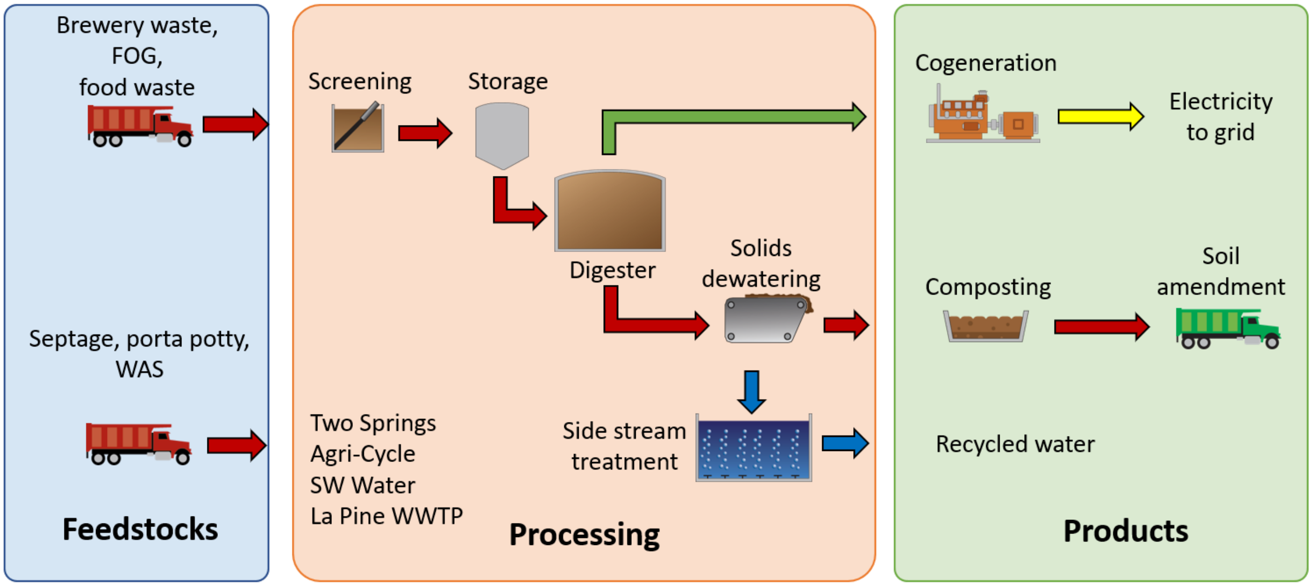

Figure 6-2: Process flow diagram of Alternative 2 – Organics Only Digestion with Cogeneration at Knott Landfill

The feedstock receiving station would be equipped with (1) a grinder and rock trap to remove inorganic material from the feedstock, (2) a 15,000-gallon steel receiving tank to store and homogenize the feedstock before transferring it to the digester, (3) mixing pumps to facilitate homogenization of the feedstock within the receiving tank, and (4) a transfer pump to transfer the feedstock from the receiving tank to the digester.

The digester was assumed to be a 250,000-gallon steel tank equipped with a heating and mixing system. The heat required to increase the digester temperature to a target of 98°F to 100°F will typically be provided by heat recovered from the microturbine. A recirculating pump mix system will provide digester mixing.

Digester gas produced from the digestion process will be captured, treated to remove moisture and siloxanes, and used as fuel for a microturbine engine. Initially, the microturbine is anticipated to produce approximately 200 kW of power using the available digester gas. However, digester gas will be flared if the microturbine is out of service for maintenance or repair.

Residual solids from the digestion process will be pumped to a centrifuge for solids dewatering. It was assumed that the centrifuge would be located beneath a canopy structure to protect the equipment and dewatered solids from exposure. Following solids dewatering, the solids would be composted through a three-phase aerated static pile process. Approximately 14,600 square feet of space is required for the composting process, which is anticipated to take approximately 8 weeks. Mixing equipment to incorporate wood and green waste organic bulking material and screening equipment to remove the bulking material after composting would also be required.

Recycled water can be recovered from the facility using a packaged membrane bioreactor treatment system. Centrate from the solids dewatering process is the stream that is anticipated to be recovered and treated using this process. Approximately 8,000 gallons/day of water could potentially be recovered for recycled water use from the facility.

Table 6-2 shows the operation and maintenance cost, anticipated revenue, capital cost, and payback period for Alternative 2. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F.

Table 6-2: Alternative 2 - Cost summary

Item	Value	Notes
Operation and Maintenance Costs	$214,197	Per year
Tipping Fee Revenue[a]	$607,130	Per year
Solids Products Revenue[b]	$19,250	Per year
Power Revenue[c]	$92,125	Per year
Gas Revenue[d]	$-	Per year
Total	**$504,308**	
Capital Cost	**$25,070,000**	
Payback Period	**50**	**Years**
(a) Assumed tipping fee of $0.11 per gallon. Analysis for other tipping fees included in Appendix D.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.2.3 Analysis of Alternative 3 - Organics Only Digestion with RNG at Knott Landfill

Alternative 3 includes hauling organic waste feedstocks, including FOG, food, and brewery waste, to a new organics digestion facility located at Knott Landfill. The primary components of the facility include the following:

- Feedstock receiving station
- Steel digester
- Biogas treatment system (shared with Knott Landfill RNG facility)
- RNG production system (shared with Knott Landfill RNG facility)
- Centrifuge solids dewatering system
- Composting system
- Recycled water treatment system

Table 6-3 includes the key the design criteria for Alternative 3.

Table 6-3: Alternative 3 - Design criteria

Item	Value	Unit
Organic Waste Volume	15,332	gallons per day
Organic Waste Volatile Solids	7,059	pounds per day
Target Hydraulic Retention Time	10	days
Receiving Tank Volume	15,000	gallons
Digester Volume[(a)]	250,000	gallons
Compost Production[(b)], start-up	550	wet tons per year at 50% solids
Compost Production[(b)], future	867	wet tons per year at 50% solids
Gas Production[(c)], start-up	64	standard cubic feet per minute
Gas Production[(c)], future	101	standard cubic feet per minute
Gas Production[(c)], peak	152	standard cubic feet per minute
RNG Production, start-up	27,610	MMBtu/year

(a) Assumed growth factor of 2.3 percent and planning period of 20 years.

(b) Assumed FOG/grease/food waste/brewery waste volatile solids reduction of 90%/90%/74%/89%, respectively.

(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.

A diagram illustrating the components of the facility is included in Figure 6-3.

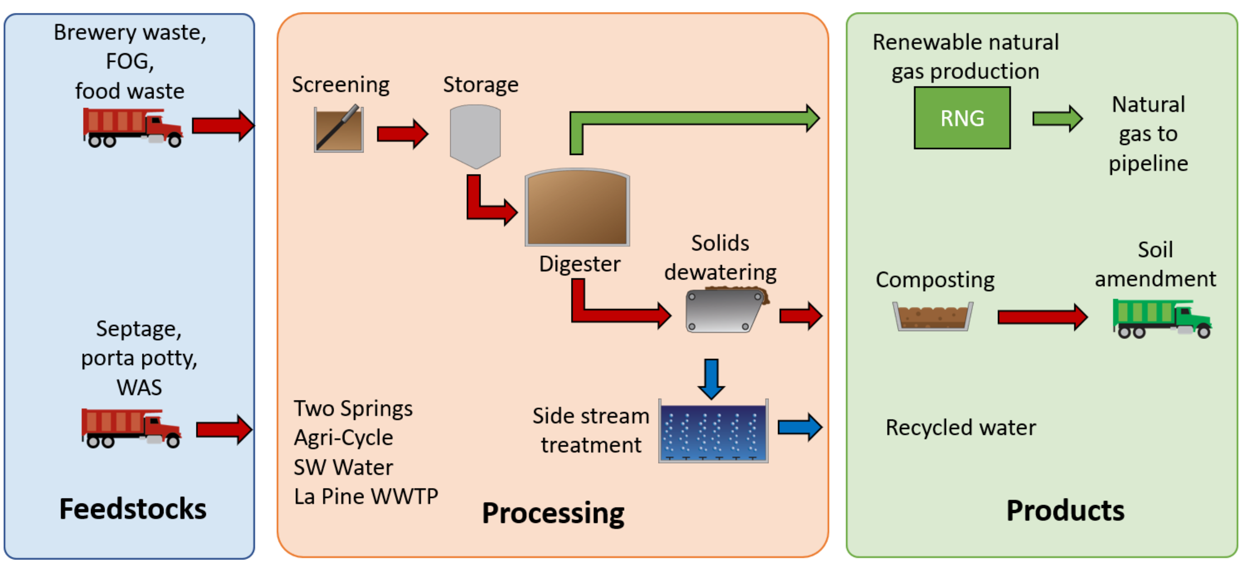

Figure 6-3: Process flow diagram of Alternative 3 – Organics Only Digestion with RNG at Knott Landfill

The feedstock receiving station would be equipped with (1) a grinder and rock trap to remove inorganic material from the feedstock, (2) a 15,000-gallon steel receiving tank to store and homogenize the feedstock before transferring it to the digester, (3) mixing pumps to facilitate homogenization of the feedstock within the receiving tank, and (4) a transfer pump to transfer the feedstock from the receiving tank to the digester.

The digester was assumed to be a 250,000-gallon steel tank equipped with a heating and mixing system. The heat required to increase the digester temperature to a target of 98°F to 100°F will typically be provided by heat recovered from the microturbine. A recirculating pump mix system will provide digester mixing.

Digester gas produced from the digestion process will be captured; treated to remove moisture, siloxanes, and carbon dioxide; and then compressed for injection into a natural gas pipeline. To develop the capital cost estimate, it was assumed that the gas treatment and compression system for the Knott Landfill project could be utilized to treat the gas produced from the organics digestion facility. Therefore, capital costs for these elements are not included in the capital cost estimate for this alternative.

Residual solids from the digestion process will be pumped to a centrifuge for solids dewatering. It was assumed that the centrifuge will be located beneath a canopy structure to protect the equipment and dewatered solids from exposure. Following dewatering, the solids would be composted through a three-phase aerated static pile process. Approximately 14,600 square feet of space is required for the composting process, and the process is anticipated to take approximately 8 weeks. Mixing equipment to incorporate wood and green waste organic bulking material and screening equipment to remove the bulking material after composting would also be required.

Recycled water can be recovered from the facility using a packaged membrane bioreactor treatment system. The centrate from the dewatering process is the stream that is anticipated to be recovered and treated using this process. Approximately 8,000 gallons/day of water could potentially be recovered for recycled water use from the facility.

Table 6-4 shows the operation and maintenance cost, anticipated revenue, capital cost, and payback period for Alternative 3. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F.

Table 6-4: Alternative 3 - Cost summary

Item	Value	Notes
Operation and Maintenance Costs	$237,445	Per year
Tipping Fee Revenue[(a)]	$607,130	Per year
Solids Products Revenue[(b)]	$19,250	Per year
Power Revenue[(c)]	$-	Per year
Gas Revenue[(d)]	$278,956	Per year
Total	**$667,890**	
Capital Cost	**$20,670,000**	
Payback Period	**31**	**Years**
(a) Assumed tipping fee of $0.11 per gallon.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.2.4 Analysis of Alternative 4 - Co-Digestion of WAS, FOG, and Food and Brewery Waste with Cogeneration at Bend WRF

Alternative 4 includes hauling organic waste feedstocks, including FOG, food and brewery waste, to a new co-digestion facility at the Bend WRF. The facility would include the following components:

- Feedstock receiving station
- Concrete digester
- Biogas treatment system
- Cogeneration engine

Table 6-5 includes the key design criteria for Alternative 4.

Table 6-5: Alternative 4 - Design criteria

Parameter	Value	Unit
Organic Waste Volume	15,332	gallons per day
Organic Volatile Solids	7,059	pounds per day
Target Hydraulic Retention Time	15	days
Receiving Tank Volume	15,000	gallons
Digester Volume(a)	630,000	gallons
Dewatered Biosolids Production(b), start-up	1,376	wet tons per year at 20% solids
Dewatered Biosolids Production(b), future	2,168	wet tons per year at 20% solids
Gas Production(c), start-up	170	standard cubic feet per minute
Gas Production(c), future	267	standard cubic feet per minute
Gas Production(c), peak	401	standard cubic feet per minute
(a) Assumed growth factor of 2.3 percent and planning period of 20 years.		
(b) Assumed FOG/grease/food waste/brewery waste volatile solids reduction of 90%/90%/74%/89%, respectively.		
(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.		

A diagram illustrating the components of the facility is included in Figure 6-4.

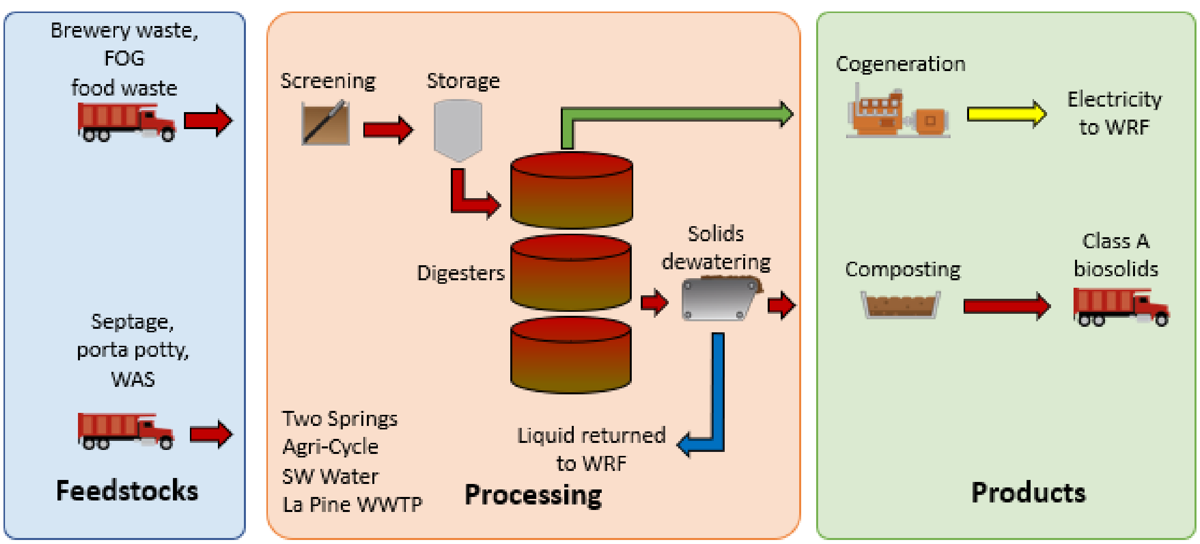

Figure 6-4: Process flow diagram of Alternative 4 – Co-Digestion at the Bend WRF

The feedstock receiving station would be equipped with (1) a grinder and rock trap to remove inorganic material from the feedstock, (2) a 15,000-gallon steel receiving tank to store and homogenize the feedstock before transferring it to the digester, (3) mixing pumps to facilitate homogenization of the feedstock within the receiving tank, and (4) a transfer pump to transfer the feedstock from the receiving tank to the digester.

A total of 250,000 gallons of digester volume would be required for this alternative. The digester was assumed to be a concrete tank equipped with a heating and mixing system. To develop the capital cost for the digester, it was assumed that a new concrete digester would be constructed at the Bend WRF to accommodate future loads and would be constructed with sufficient volume to allow for external feedstock delivery. Only the cost of the volume required for digestion was included in the capital cost estimate. In practice, the co-digestion feedstock should be fed equally to each of the WRF digesters, rather than exclusively to one digester. The heat required to increase the digester temperature to a target of 98°F to 100°F would typically be provided by heat recovered from the cogeneration engine. Digester mixing would be provided by a recirculating pump mix system.

Biogas produced would be treated to remove siloxanes and hydrogen sulfide, then conveyed to a cogeneration engine to be used as fuel. An approximately 850-kW cogeneration engine would be provided to utilize the biogas. The cogeneration engine is not anticipated to be operated at full capacity in the initial years after the project is on-line because the amount of biogas generated will not be sufficient to run the engine at full capacity. However, as the population of the region grows or if additional organic feedstocks are identified, the engine would be operated at a higher capacity, and additional electricity would be produced. One of the advantages of the Bend WRF is the ability to add the digester gas that is already being produced by the WRF to fuel the cogeneration engine. As a result of the availability of this gas, significantly more electricity can be produced compared to alternatives located at the other sites. If the cogeneration engine is out of service due to maintenance or repair, the biogas would be flared using the WRF's existing biogas flare.

Residual biosolids produced from the co-digestion process were assumed to be processed through the WRF's existing solids dewatering equipment. Dewatered solids were assumed to be dried in the existing solids drying beds and land applied. The operations cost per ton of processing the biosolids was calculated based on operating cost information received from the City. Table 6-6 shows the O&M cost, anticipated revenue, capital cost, and payback period for Alternative 3. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F.

Table 6-6: Alternative 4 - Cost summary

Item	Value	Notes
Operation and Maintenance Costs	$267,277	Per year
Tipping Fee Revenue[(a)]	$607,130	Per year
Solids Products Revenue[(b)]	$-	Per year
Power Revenue[(c)]	$309,426	Per year
Gas Revenue[(d)]	$-	Per year
Total	**$649,279**	
Capital Cost	**$12,200,000**	
Payback Period	**19**	**Years**
(a) Assumed tipping fee of $0.11 per gallon.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.2.5 Analysis of Alternative 5 - Co-Digestion of FOG, Food, and Brewery Waste, and Septage with Cogeneration at Bend WRF

The infrastructure required for Alternative 5 is identical to Alternative 4. The difference between the two alternatives is the organic waste feedstocks that would be fed to the process. Alternative 5 feedstocks include FOG, food, and brewery waste, and septage waste. The facility would include the following components:

- Feedstock receiving station
- Concrete digester
- Biogas treatment system
- Cogeneration engine

Table 6-7 includes the key the design criteria for Alternative 5.

Table 6-7: Alternative 5 - Design criteria

Parameter	Value	Unit
Organic + 50% Septage Waste Volume	26,462	gallons per day
Organic + 50% Septage Waste Volatile Solids	8,183	pounds per day
Target Hydraulic Retention Time	15	days
Receiving Tank Volume	15,000	gallons
Digester Volume[(a)]	630,000	gallons
Dewatered Biosolids Production[(b)], start-up	2,006	wet tons per year at 20% solids
Dewatered Biosolids Production[(b)], future	3,161	wet tons per year at 20% solids
Gas Production[(c)], start-up	176	standard cubic feet per minute
Gas Production[(c)], future	277	standard cubic feet per minute
Gas Production[(c)], peak	415	standard cubic feet per minute
((a) Assumed growth factor of 2.3 percent and planning period of 20 years.		
(b) Assumed FOG/grease/food waste/brewery waste/septage volatile solids reduction of 90%/90%/74%/89%/50%, respectively.		
(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.		

A diagram illustrating the components of the facility is included in Figure 6-5.

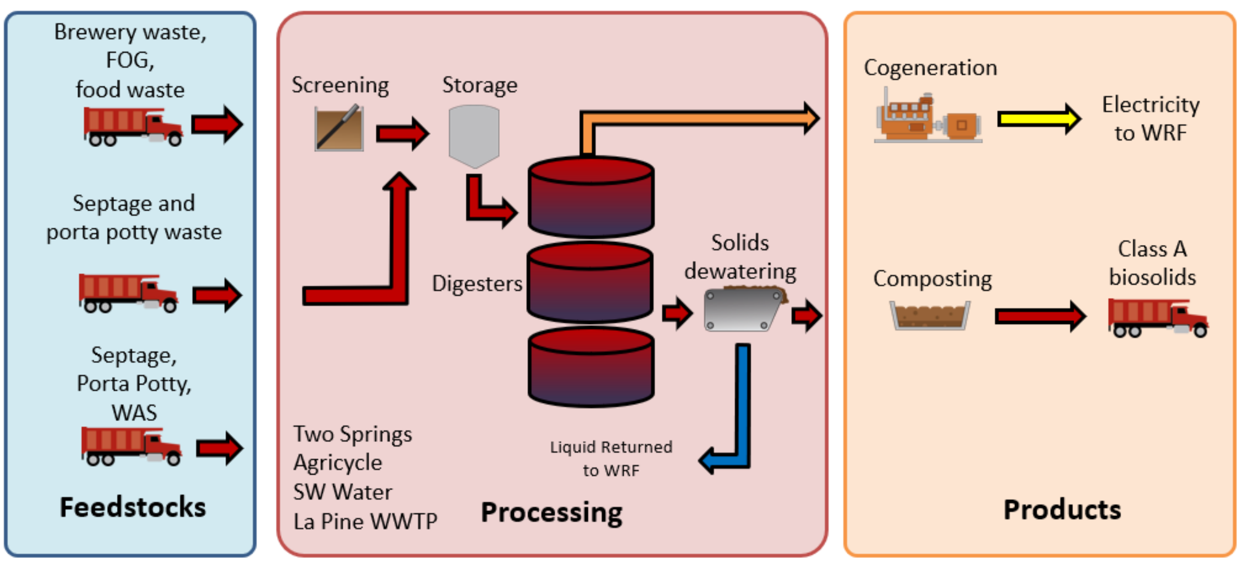

Figure 6-5: Process flow diagram of Alternative 5 – Co-Digestion with septage receiving at the Bend WRF

A total of 625,000 gallons of digester volume would be required for this alternative. Like Alternative 4, the digester was assumed to be a concrete tank equipped with a heating and mixing system. To develop the capital cost for the digester, it was assumed that a new concrete digester would be constructed at the Bend WRF to accommodate future loads. It would be constructed with sufficient volume to allow for external feedstock delivery. Only the cost of the volume required for digestion was included in the capital cost estimate.

The additional septage feedstock represents a significant amount of additional feedstock volume compared to the feedstock volume for Alternative 4, which results in significantly more tipping fee revenue than Alternative 4. However, it should be noted that while the volume of feedstock is greater, the increase in biogas production is modest. This is because it was assumed that much of the volatile solids content of the septage waste would be consumed while the waste is stored in septage tanks or chemical toiles prior to feedstock delivery to the Bend WRF. As a result, Alternative 5 is anticipated to produce only 6 standard cubic feet per minute of additional biogas compared to Alternative 4.

Table 6-8 shows the O&M cost, anticipated revenue, capital cost, and payback period for Alternative 5. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F.

Table 6-8: Alternative 5 - Cost summary

Item	Value	Notes
Operation and Maintenance Costs	$(46,641)	Per year
Tipping Fee Revenue[(a)]	$1,047,895	Per year
Solids Products Revenue[(b)]	$-	Per year
Power Revenue[(c)]	$322,211	Per year
Gas Revenue[(d)]	$-	Per year
Total	**$1,416,746**	
Capital Cost	**$15,180,000**	
Payback Period	**11**	**Years**
(a) Assumed tipping fee of $0.11 per gallon.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.2.6 Analysis of Alternative 6 - Organics Only Digestion with Microturbine at Redmond RV Dump Station

Alternative 6 is identical to Alternative 2, except the facility would be located at the Redmond RV Dump Station instead of the Knott Landfill. The same hauled organic waste feedstocks are anticipated to be delivered to the site, including FOG, food, and brewery waste. The primary components of the facility include the following:

- Feedstock receiving station
- Steel digester
- Biogas treatment system
- Microturbine power generation system
- Centrifuge solids dewatering system
- Composting system
- Recycled water treatment system

Table 6-9 includes the key design criteria for Alternative 6.

Table 6-9: Alternative 6 - Design criteria

Item	Value	Unit
Organic Waste Volume	15,332	gallons per day
Organic Waste Volatile Solids	7,059	pounds per day
Target Hydraulic Retention Time	10	days
Receiving Tank Volume	15,000	gallons
Digester Volume[(a)]	250,000	gallons
Compost Production[(b)], start-up	550	wet tons per year at 50% solids
Compost Production[(b)], future	867	wet tons per year at 50% solids
Gas Production[(c)], start-up	64	standard cubic feet per minute
Gas Production[(c)], future	101	standard cubic feet per minute
Gas Production[(c)], peak	152	standard cubic feet per minute
(a) Assumed growth factor of 2.3 percent and planning period of 20 years.		
(b) Assumed FOG/grease/food waste/brewery waste volatile solids reduction of 90%/90%/74%/89%, respectively.		
(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.		

A diagram illustrating the components of the facility is included in Figure 6-6.

Figure 6-6: Process flow diagram of Alternative 6 – Organics Only Digestion with Cogeneration at the Redmond RV Dump Station

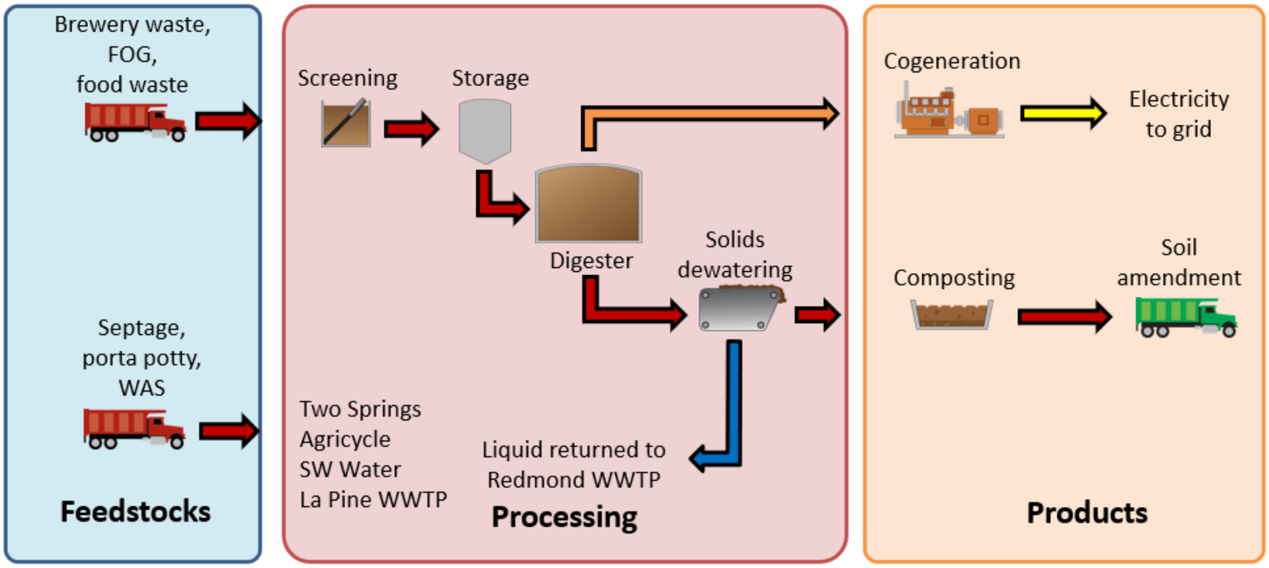

Table 6-10 shows the O&M cost, anticipated revenue, capital cost, and payback period for Alternative 6. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F. The capital cost and O&M cost are the same as the capital cost and O&M cost for Alternative 2.

Table 6-10: Alternative 6 - Cost Summary

Item	Value	Notes
Operation and Maintenance Costs	$214,197	Per year
Tipping Fee Revenue[(a)]	$607,130	Per year
Solids Products Revenue[(b)]	$19,250	Per year
Power Revenue[(c)]	$92,125	Per year
Gas Revenue[(d)]	$-	Per year
Total	**$504,308**	
Capital Cost	**$25,070,000**	
Payback Period	**50**	**Years**
(a) Assumed tipping fee of $0.11 per gallon.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.2.7 Analysis of Alternative 7 - Organics Only Digestion at Knott Landfill with RNG and Hauled Digestate to Bend WRF

Alternative 7 is similar to Alternative 3; both alternatives involve processing organic feedstocks at Knott Landfill and producing RNG. The same hauled organic waste feedstocks are anticipated to be processed at the site, including FOG, food, and brewery waste. The primary difference between Alternative 7 and Alternative 3 is in the solids processing; the digestate produced from Alternative 7 would be hauled by truck to the Bend WRF for dewatering, drying, and ultimately land application as biosolids. The primary components of the facility include the following:

- Feedstock receiving station
- Steel digester
- Biogas treatment system (shared with Knott Landfill RNG facility)
- RNG production system (shared with Knott Landfill RNG facility)
- Centrifuge solids dewatering system
- Composting system
- Recycled water treatment system

Table 6-11 includes the key the design criteria for Alternative 7.

Table 6-11: Alternative 7 - Design criteria

Item	Value	Unit
Organic Waste Volume	15,332	gallons per day
Organic Waste Volatile Solids	7,059	pounds per day
Target Hydraulic Retention Time	10	days
Receiving Tank Volume	15,000	gallons
Digester Volume[(a)]	250,000	gallons
Digestate Production[(b)], start-up	9,170	wet tons per year at 3% solids
Digestate Production[(b)], future	14,451	wet tons per year at 3% solids
Gas Production[(c)], start-up	64	standard cubic feet per minute
Gas Production[(c)], future	101	standard cubic feet per minute
Gas Production[(c)], peak	152	standard cubic feet per minute
(a) Assumed growth factor of 2.3 percent and planning period of 20 years.		
(b) Assumed FOG/grease/food waste/brewery waste volatile solids reduction of 90%/90%/74%/89%, respectively.		
(c) Assumed gas production of 15 standard cubic feet per pound of volatile solids.		

A diagram illustrating the components of the facility is included in Figure 6-7.

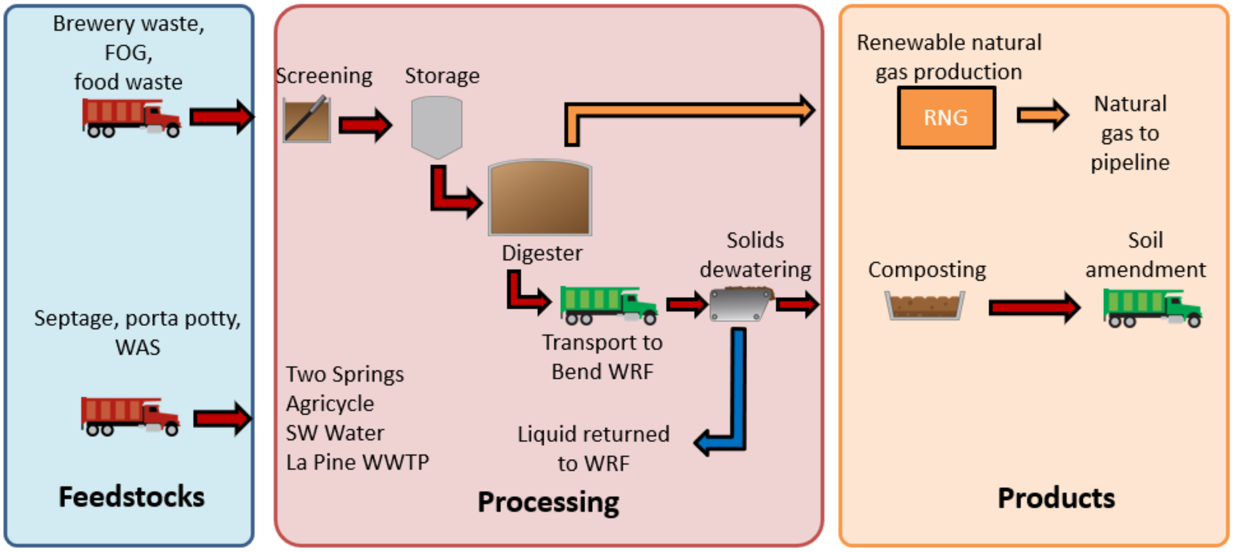

Figure 6-7: Process flow diagram of Alternative 7 – Organics Only Digestion at Knott Landfill with RNG and Digestate Processing at Bend WRF

The feedstock receiving station and digester would be identical to the facilities provided for Alternative 3. Additionally, like Alternative 3, it was assumed that the gas treatment and compression system for the Knott Landfill project could be utilized for the treatment of the gas produced from the organics digestion facility. Therefore, capital costs for these elements are not included in the capital cost estimate for this alternative.

The digestate produced from Alternative 7 would be hauled by truck to the WRF for dewatering, drying, and ultimately land application as biosolids. The cost associated with hauling this waste is reflected in the O&M cost estimate prepared for this alternative. The operating cost associated with processing the hauled digestate at the WRF, including dewatering and drying processes, is also incorporated into the O&M cost estimate.

Table 6-12 shows the O&M cost, anticipated revenue, capital cost, and payback period for Alternative 7. The detailed capital cost estimate for the alternative is included in Appendix E, and a detailed operations cost estimate for the alternative is included in Appendix F.

Table 6-12: Alternative 7 - Cost summary

Item	Value	Notes
Operation and Maintenance Costs	$340,763	Per year
Tipping Fee Revenue[(a)]	$607,130	Per year
Solids Products Revenue[(b)]	$-	Per year
Power Revenue[(c)]	$-	Per year
Gas Revenue[(d)]	$278,956	Per year
Total	**$745,412**	
Capital Cost	**$15,660,000**	
Payback Period	**29**	**Years**
(a) Assumed tipping fee of $0.11 per gallon.		
(b) Assumed compost unit price of $35 per wet ton and 550 wet tons produced per year at 50% solids.		
(c) Assumed power unit cost of $0.057 per kWh and 1,616,220 kWh produced per year.		
(d) Assumed gas unit cost of $4.026 per MMBtu and 19,589 MMBtu produced per year.		

6.3 Payback Period Summary

A simple payback analysis was performed to assess the value of the products from the co-digestion of organic feedstocks. The simple payback analysis calculates the number of years of operation required for the project to pay for itself. The results of the simple payback analysis for the digestion facilities are summarized in Table 6-13.

Table 6-13: Payback period in years based on different tipping fees

Alternative	Payback Period (Years)		
Tipping Fee	$0.11/gal	$0.20/gal	$0.30/gal
1	N/A	N/A	N/A
2	50	25	16
3	31	18	12
4	19	11	7
5	11	7	5
6	50	25	16
7	29	15	10

Note that a tipping fee of $0.11/gal was selected because it represents the current market rate tipping fee; however, the two higher tipping fees were included in the analysis to evaluate the impact on the simple payback period. As expected, a higher tipping fee significantly reduces the simple payback period.

Alternatives 4 and 5 have the shortest simple payback period. This is due primarily to the location of both alternatives at the WRF. Because of the location of these alternatives, both can take advantage of the existing biosolids infrastructure at the WRF, reducing capital costs. Additionally, both alternatives can utilize gas produced by the WRF's existing digesters to produce additional electricity, increasing the value of products for these alternatives compared to the other alternatives. Finally, Alternative 5 includes accepting a significantly higher volume of waste compared to other alternatives, increasing revenue.

6.4 Sensitivity Analysis

There is a point where the organics feedstocks will be large enough in volume to tip the simple payback towards an organics-only facility. There are feedstocks that are currently unaccounted for because they are not disposed of as hauled waste, this includes food waste and brewery waste. A sensitivity analysis was conducted to see how the simple payback would change if the high-strength brewery waste and food waste feedstocks were doubled.

The results in Table 6-14 show that the ranking of alternatives for simple feedback was unchanged in the sensitivity analysis. As expected, the payback period is reduced when accepting the additional waste because of the increased tipping fee revenue (because more volume is received) and increased product revenue (more gas, more compost). For Alternatives 4 and 5, the payback periods were reduced by 9 years and 3 years, respectively. The payback periods for the other alternatives were still higher than Alternative 4 and 5. This sensitivity analysis does not account for increased capital costs that would be required or the additional O&M costs.

Table 6-14: Simple payback in years comparison between original alternatives analysis and sensitivity analysis results

Alternative	Original results [(a)]	Sensitivity analysis [(a) (b)]
1	N/A	N/A
2	50	24
3	31	16
4	19	10
5	11	8
6	50	24
7	35	13

(a) Assumes $0.11/gal tipping fee

(b) Doubles feedstock volume for brewery waste and food waste

7 Triple Bottom Line

Evaluating an RRR facility has many elements that were considered to properly incorporate the key challenges and opportunities. The alternatives analysis used the TBL methodology, which is an accounting framework that comprehensively quantifies non-cost and cost factors. The project team used the TBL metrics to include contributions to environmental health, social well-being, and a fair economy—the three pillars of sustainable infrastructure.

Four Stakeholder Committee workshops were held by the COB and attended by various government agencies, businesses, and utilities to ensure input from diverse stakeholders. In these workshops, the stakeholders defined the criteria under each of the established TBL evaluation criteria and weighting factors (see Table 7-1) based on the stakeholder's knowledge and experience. A total of 15 evaluation criteria were defined, and each alternative was analyzed using the criteria and scored accordingly.

The seven alternatives are as follows:

- Alternative 1 – Status Quo
- Alternative 2 – Organics Only Digestion with Microturbine at Knott Landfill
- Alternative 3 – Organics Only Digestion with RNG at Knott Landfill
- Alternative 4 – Co-digestion of WAS, FOG, Food, and Brewery Waste with Cogeneration at Bend WRF
- Alternative 5 – Co-digestion of WAS, FOG, Food, Brewery Waste, and Septage with Cogeneration at Bend WRF
- Alternative 6 – Organics Only Digestion with Cogeneration at Redmond RV Dump Station
- Alternative 7 – Organics Only Digestion at Knott Landfill and Hauled Digestate to Bend WRF

Table 7-1: Triple Bottom Line Analysis weighted scores

Environmental (38%)		Social (24%)		Economic (38%)	
Greenhouse Gas Emissions	9.5%	**Odor Control**	4.7%	**Costs - Capital, Lifecycle, Hauling**	11.7%
Beneficial Use	8.1%	**Public Acceptance**	4.6%	**Reliability/Resiliency**	10.5%
Environmental Risk	8.0%	**Allows For Population Growth**	4.5%	**Revenue - Tipping Fees, Energy/RNG/Residuals**	9.5%
Potential For Facility Co-Location	6.4%	**Social Equity**	3.5%	**Incentives**	6.3%
Permitting Complexity	5.9%	**Provides Educational Opportunities**	3.4%		

7.1 TBL Economic Category

The TBL economic category considers the traditional economic factors of the project. Four criteria were developed under the cost category: Costs, Revenue, Reliability and Resiliency, and Incentives. A scoring rubric and measures were developed for each evaluation criterion. Table 7-2 summarizes of the results of the Economic TBL analysis.

Table 7-2: Scoring rubric for TBL economic criteria

Criteria Score	1	3	5
Costs - Capital, lifecycle, and hauling	High cost	Medium cost	Low cost
Revenue - Tipping fees, energy/RNG/residuals	Tipping fees and residual products are priced above market value.	Tipping fees and residual products are priced at market value.	Tipping fees and residual products are priced below market value.
Reliability and resiliency	Insufficient redundancy of mechanical components are included in the project. Little resilience to change in feedstocks or regulations. Low operational reliability.	Partial redundancy of major mechanical components. Partially resilient to change in regulation and/or feed supply/product demand. Medium operational reliability.	Sufficient redundancy of mechanical components is included in the project. Infrastructure is resilient to changes in regulations and feed supply/product demand. High operational reliability.
Incentives	Project is ineligible for funding that supports implementation.	Project is eligible for some funding incentives, but not maximum funding.	Maximum funding incentives exist for project implementation.

7.1.1 Costs - Capital, Lifecycle, and Hauling

Capital, lifecycle, and hauling costs were scored based on the simple payback. Simple payback incorporates the revenue from products and tipping fees, capital costs, and O&M costs. A summary of alternative costs and tipping fees can be found in Appendix D. The simple payback is calculated as the total annual net revenue divided by the capital costs. Cost analysis results are shown in Figure 7-1. Ideally, an infrastructure project will have less than a 20-year return on investment.

The co-digestion alternatives, Alternatives 4 and 5, had the shortest simple payback at less than 20 years. The difference between Alternatives 4 and 5 is the volume of feedstocks received. Due to the revenue potential from the excess tipping fees from septage, WAS, and porta potty waste, it would be advantageous for the COB to build in septage receiving into the WRF.

Alternative 7 and 3, both utilizing RNG generation at the Knott Landfill, had the next lowest simple payback period at 29 and 31 years, respectively. These alternatives may have the potential for private partnerships with local natural gas utilities that are not realized in this analysis, which could reduce the years for simple payback.

Alternative 1, Status Quo, was left out of the simple payback analysis. From the ratepayer's point of view, the COB is paying approximately $500,000 per year for a third party to handle hauled wastes. It is difficult to compare a contract cost to a capital cost as contracts are variable and tend to keep appreciating over time, like renting a home rather than buying. Therefore, Alternative 1 was assigned a neutral score of 3 because private companies across Central Oregon are currently making a profit, but ratepayers are not.

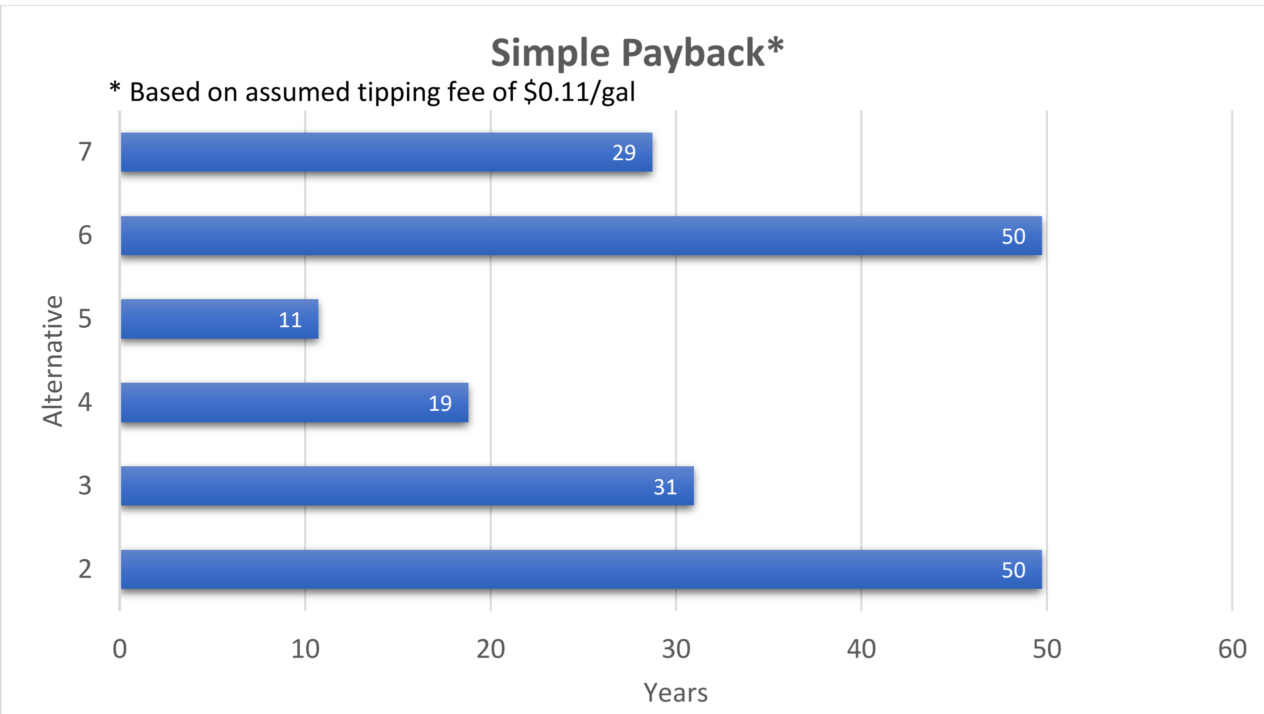

Figure 7-1: Summary of simple payback by alternative

Table 7-3 shows the final TBL scores for the Cost criterion (capital, lifecycle, and hauling costs).

Table 7-3: Final TBL scores for the Cost criterion

Cost (Capital, Lifecycle, and Hauling) Score							
Alternative	1	2	3	4	5	6	7
Score	3	1	2	3	4	1	2

7.1.2 Reliability/Resiliency

Reliability is the ability of the infrastructure to remain operational. Resiliency is the ability of infrastructure to adapt to or withstand a disruptive event or changing conditions. An initiative-taking response to possible catastrophic events or adaptations is economically advantageous, as costs tend to rise significantly in a reactionary situation. For this project, reliability and resilience were measured by the following four inputs:

1) Is there equipment redundancy within the process?
2) How reliable is the operation of the process/technology?
3) Is the alternative resilient to a change in feedstock supply and/or product demand?
4) Is the alternative resilient to changes in regulations?

The summary of the analysis for resilience and redundancy and final TBL scores are included in Table 7-4. Alternatives 4 and 5 generally scored the highest because the co-digestion processes are regulated as municipal wastewater treatment infrastructure, requiring redundancy and process reliability. Additionally, these processes are more resilient to change in hauled waste feedstocks because the majority of feed supply is from the wastewater collection system, allowing the digesters to continue regardless of the amount of hauled waste feedstock received.

Alternatives 2, 3, 6, and 7 ranked the next highest. Alternatives 2, 3, 6, and 7 are industrial processes, and although are considered reliable, they do not have the same regulatory requirements for redundancy and reliability as the co-digestion processes in Alternative 4 and 5. Stand-alone organics digestion alternatives are not as resilient to feed supply changes because a major decrease in hauled waste inputs could make the process unable to generate net revenue. The compost solids product is resilient to regulation change and allows the greatest flexibility for solids product reuse. Alternative 3's end product is RNG, which is less resilient than cogeneration to changes in regulation as the Western states pass policies that move away from using natural gas.

The lowest ranking alternative is Alternative 1, Status Quo. This alternative is operationally reliable but is at risk due to changes in regulations. It is anticipated that the land application of FOG will be discontinued in future regulatory policy updates. Additionally, the land application of lime-stabilized solids is already land-limited in Central Oregon, and there is no resilience to an increase in feedstock supply.

Table 7-4: Summary of Reliability and Resiliency criteria scores

Alternative	1	2	3	4	5	6	7
Equipment redundancy	No.	Partially redundant. Facilities are assumed to be designed with redundant pumping equipment, but without redundant tankage, gas utilization equipment, and dewatering equipment.		Partially redundant. Must achieve regulatory required level of redundancy for municipal wastewater facilities.		Partially redundant. Facilities are assumed to be designed with redundant pumping equipment, but without redundant tankage, gas utilization equipment, and dewatering equipment.	
Operational reliability	Hauling and application processes are assumed to be reliable.	Equipment to be installed and processes to be implemented are generally considered to be reliable.					
Resilience to change in feed supply/product demand	Some limited available land for an increase in feedstocks.	No, cannot operate without feedstock.		Yes, could operate digester and cogeneration equipment without external feedstock.		No, cannot operate without feedstock.	
Resilience to change in regulations	No, vulnerable to changes restricting the land application of lime-stabilized waste.	Yes, the absence of human waste allows for more options for solids product use.		Partially resilient, vulnerable to changes restricting the land application of biosolids.		Yes, the absence of human waste allows for more options for solids product use.	
Score	2	3	3	4	4	3	3

7.1.3 Revenue – Tipping Fees, Energy/RNG/Residuals

Revenue was measured by the ability of the alternative to generate revenue with tipping fees and residual products. For the alternative to pencil out, tipping fees need to be set at a rate that will allow for net revenue. The scoring rubric is based on a comparison of current market rate tipping fees to the tipping fee required for the alternative to generate net revenue. The current average market rate in Central Oregon is \$0.11 per gallon of hauled waste.

Figure 7-2 contains the value of all resources and the gross and net revenue. Net revenue deducts O&M expenses from the gross revenue. The value of power, natural gas, and compost (at 50% solids) were based on current market rates of \$0.057 \$/kWh, \$4/MMBtu, and \$35/wet ton, respectively. Alternative

1 creates revenue for private entities but generates no net revenue for the ratepayer, thus is reflected as zero net revenue.

A Renewable Identification Number (RIN) credit is generated each time a gallon of renewable fuel is created, including RNG. RIN is a program generated by the EPA to track compliance with the Renewable Fuel Standard Program (RFS). Under the RFS, oil refineries are required to blend a percentage of renewable fuel compared to their total refinery production. Entities that do not have a regulatory obligation, like a digestion facility, can sell their RINs on the market to other obligated refiners. Alternative 3 and 7 would produce RIN credits. A rate of $0.97/RIN was assumed for calculations based on the average RIN rate over the past 3 years. The RIN credit market fluctuates constantly, a half of a point score was reduced from Alternative 3 and 7 to reflect the uncertainty associated with the RIN market.

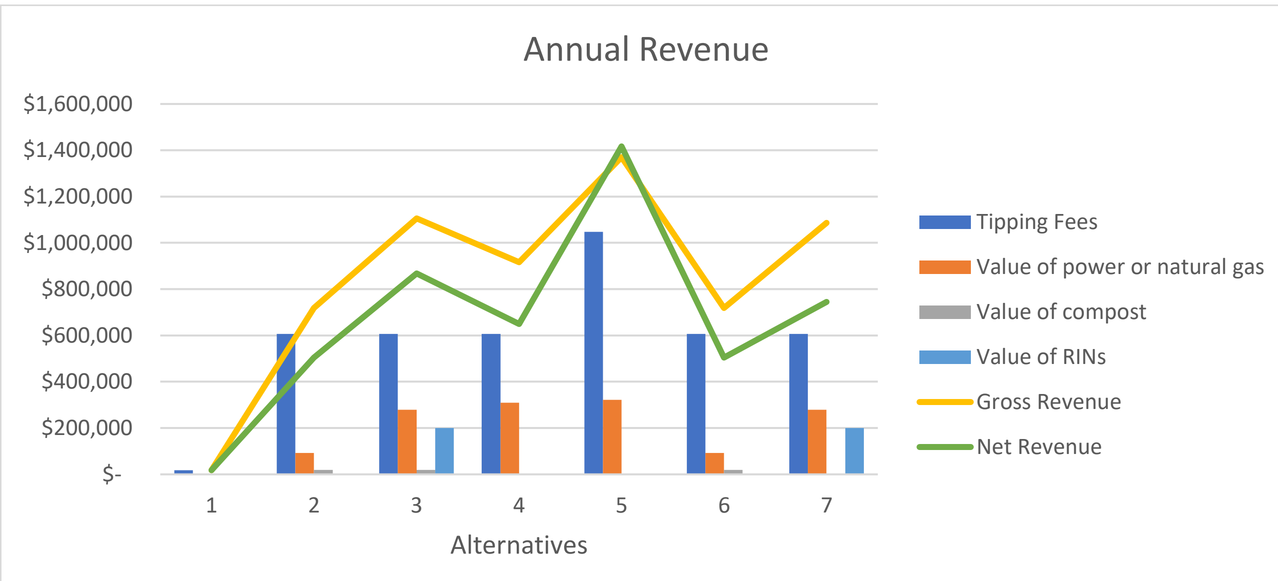

Figure 7-2: Comparison of alternative revenue sources

Table 7-5 includes the final scores for the revenue criteria.

Table 7-5: Scores for the revenue criteria

TBL – Costs – Revenue							
Alternative	1	2	3	4	5	6	7
Score	2.0	2.5	3.5	3.0	5.0	2.5	3.0

7.1.4 Incentives

The incentives for an energy-from-waste project are based on the type of products produced and public utilities that service the site. Energy Trust of Oregon funding requires the project to be on the Pacific Power electrical grid; all alternative project sites are located in the Central Electric Co-Op (CEC) service area. CEC should have funding incentives available for electric energy projects, but the staff failed to return any of the project team's calls or emails.

Additionally, many federal and state grant funding programs are available for environmental projects. Possible funding sources include:

- Oregon Department of Energy Community Renewable Energy Grant Program
- Energy Trust of Oregon
- EPA federal recycling, reuse, and waste prevention grant programs and initiatives
- U.S. Department of Agriculture (USDA) Rural Energy for America Program: Renewable Energy and Energy Efficiency

Table 7-6 includes the summary of incentives available per alternative and the final TBL score for the criteria. For the basis of analysis, the capital costs were calculated assuming no grant funding; any additional funding that the COB secures will improve the project's simple payback. Alternative 1 has existing infrastructure; therefore, no additional grant funding opportunities exist that benefit the Central Oregon ratepayer.

Table 7-6: Scores for the Incentives criteria

Alternative	1	2	3	4	5	6	7
Incentives for Project Funding	N/A	Water reuse, composting, and electricity/heat recovery.	Water reuse, composting, and the potential for RIN credit availability.	Biosolids and electricity/heat recovery.	Biosolids and electricity/heat recovery.	Water reuse, composting, and electricity/heat recovery.	Biosolids, potential for RIN credit availability
Score	1	4	3	4	4	4	3

7.2 TBL Social Category

Social impacts can have a wide range of definitions but are generally described for this project evaluation as the relationship between the facility's location, social equity, and ability to promote community health and safety. There were six criteria developed under the social category: odor control, public acceptance, allowance for population growth, social equity, educational opportunities, and development of diverse community partnerships. A scoring rubric and measures were developed for each evaluation criterion, shown in Table 7-7.

Table 7-7: Scoring rubric for Social criteria

Social Criteria	Score of 1	Score of 3	Score of 5
Odor control	The project has the potential to generate significant odors and would be located near sensitive odor receptors.	The project has the potential to generate significant odors and would not be located near sensitive odor receptors.	The project does not have the potential to generate significant odors and would not be located near sensitive odor receptors.
Public acceptance	Significant barriers to public acceptance exist, such as new traffic impacts, application of biosolids, proximity to residential areas, or negative visual impact to the surrounding landscape.	Some barriers to public acceptance exist, such as new traffic impacts, application of biosolids, proximity to residential areas, or negative visual impact to the surrounding landscape.	Few barriers to public acceptance exist.
Allowance for population growth	Sufficient capacity is planned for the project to allow for the capital components to serve the population for less than 5 years.	Sufficient capacity is planned for the project to allow for the capital components to serve the population for 20 years.	Sufficient capacity is planned for the project to allow for the capital components to serve the population for at least 50 years.
Social equity	The project disproportionately impacts certain regions and/or demographics.	The project has some disproportionate impacts to regions and/or demographics.	The project impacts all regions and demographics equally.
Educational opportunities	The project doesn't provide educational opportunities for GHG emissions or RRR. It does not promote positive community behavior changes. There is no enhancement of existing outreach programs.	The project promotes positive community behavior changes and/or provides educational opportunities on GHG emissions or RRR.	The project provides educational opportunities for GHG emissions or RRR. It promotes positive community behavior changes and enhances existing outreach programs.
Development of diverse community partnerships	Average of one out of five vote from the stakeholder committee.	Average of three out of five vote from the stakeholder committee.	Average of a five out of five vote from the stakeholder committee.

7.2.1 Odor Control

The New York State Department of Environmental Conservation provides recommended buffer distances between treatment technologies and the general public, as shown in Table 7-8. The recommended buffer distances and distance between site locations and the closest residential area were used to measure the impact of odor control.

Table 7-8: Suggested buffer distances between treatment processes and the public

Treatment Process	Buffer Distance (ft)
Open drying beds	500
Digesters	500
Sludge handling units	1000

Table 7-9 lists the distance between the alternative siting locations and the closest residential area or school. Alternatives located at the Knott Landfill were within the buffer distance and did have the potential to generate an odor. All other alternatives were sited far from sensitive receptors. Table 7-10 displays the final TBL odor control criteria scores.

Table 7-9: Distance from the Alternative site and the closest residential areas

Location	Distance (ft)
From WWTP to closest residential zone	4,130
From Knott Landfill to closest sensitive area	800
From Redmond RV Dump Station to closest residential zone	4,460

Table 7-10: Scores for the odor control criterion

TBL – Odor Control							
Alternative	1	2	3	4	5	6	7
Score	5	2	2	5	5	5	2

7.2.2 Public Acceptance

The public's level of acceptance for each alternative was measured based on the following questions:

- What is the proximity to residential areas?
- Does the alternative impact the landscape?
- Does the alternative impact traffic? If so, what is the traffic increase?

- Could public perception impact the use of the product?

Table 7-11 summarizes the results of the analysis and final TBL scores for public acceptance. Alternatives 4, 5, and 6 received the highest scores. Alternatives 2, 3, and 7, all located at Knott Landfill, were lower in score due to the proximity to residential areas. Alternative 1 scored the lowest because public acceptance is limiting the land application of lime-stabilized solids, reducing the ability of this practice to increase capacity to match the region’s growth.

Table 7-11: Scores for the Public Acceptance criterion

TBL – Public Acceptance							
Alternative	1	2	3	4	5	6	7
Proximity to residential area (ft)	Various	800	800	4,130	4,130	4,460	800
Impact on landscape	Unchanged	Minimal					
Traffic impacts	Unchanged	92 truck trips per month					150 truck trips per month
Ability of haulers to apply biosolids on local land	Public acceptance limiting land application	General acceptance of compost		General acceptance of Class A; Class B application limited		General acceptance of compost	General acceptance of Class A; Class B application limited
Score	2	3	3	4	4	4	3

7.2.3 Allowance for Population Growth

The ability to allow for population growth was based on the processing capacity and the length of time that capacity would serve the population. Alternative 1 is already at capacity and allows for zero years of population growth. The remaining alternatives were assumed to provide 20 years of capacity because infrastructure projects are usually designed for a 20-year life span. Table 7-12 contains the scores for the category.

Table 7-12: Scores for the Population Growth criterion

TBL – Allows for Population Growth							
Alternative	1	2	3	4	5	6	7
Score	1	3	3	3	3	3	3

7.2.4 Social Equity

Social equity measures the fairness of social policy. For this project, social equity was defined by the impacts on regions and demographics. Digestion facilities, although innovative infrastructure, are often seen as a negative if placed near residential areas and could impact home values and landscape views. Social equity was evaluated by the alternative location and the proximity to disadvantaged and minority population communities. Socioeconomic data were pulled from EPA's Environmental Justice Screening and Mapping Tool (EPA, 2022).

None of the potential sites are located within a higher-than-average minority population community. The Redmond site is located within a low-income area (with an 80th to 90th low-income percentile compared to the average) and scored lower accordingly. The remaining sites were not located within disadvantaged communities. Table 7-13 includes the final scores:

Table 7-13: Scores for the Social Equity criterion

TBL – Social Equity							
Alternative	1	2	3	4	5	6	7
Score	5	5	5	5	5	2	5

7.2.5 Educational Opportunities

The ability of an alternative to provide education opportunities was defined using the following three measures:

- Will the alternative promote source separation or other positive community behavior changes?
- Will the alternative provide educational opportunities on GHG emissions or RRR?
- Will the alternative provide enhancement of existing outreach programs?

Alternatives 2 through 7 all provide the opportunity to expand on the existing food waste program. Currently, Deschutes County Waste collects food waste from commercial entities for composting, but it has reached its composting capacity. If a digester for RRR was built in Central Oregon, the region could expand the commercial food waste program to residential homes. Education programs can help people change their behaviors to separate food waste from landfill wastes for resource recovery. The Bend Environmental Center, in collaboration with Deschutes County Waste and Deschutes County, has been completing work on reducing the amount of food waste and source separation in the region. All three of these stakeholders have expressed interest in partnering with the City on this project for educational outreach.

Alternative 1 continues the status quo operation in the area and provides no further educational opportunities.

Table 7-14 summarizes the findings.

Table 7-14 Summary of findings for Educational Opportunities by alternative

Resource	Alternative						
	1	2	3	4	5	6	7
Provides educational opportunities	Minimal	Yes	Yes	Yes	Yes	Yes	Yes
Promotes source separation or other behavior change	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Enhances existing outreach programs	No	Yes	Yes	Yes	Yes	Yes	Yes

Scores for this criterion are shown in Table 7-15.

Table 7-15: Scores for the Educational Opportunities criterion

TBL – Educational Opportunities							
Alternative	1	2	3	4	5	6	7
Score	2	5	5	5	5	5	5

7.2.6 Development of Diverse Community Partnerships

The Stakeholder Committee was made up of diverse groups of regional stakeholders. These stakeholders voted to determine the final criteria score based on the scoring criteria in Table 7-7. The final scores for each alternative are shown in Table 7-16.

Table 7-16: Scores for the Diverse Community Partnerships criterion

TBL – Development of Diverse Community Partnerships							
Alternative	1	2	3	4	5	6	7
Score	1	3	3.5	3	4	2	3

7.3 TBL Environmental Category

The Environmental category connects each alternative to its impact on air, water, and land ecosystems. There are five criteria developed under the Environmental category: GHG emissions, beneficial use, environmental risk, the potential for facility co-locations, and permitting complexity. The scoring rubric and measures in Table 7-17 were developed for each criterion.

Table 7-17: Scoring rubric for Environmental criteria

Environmental	Score of 1	Score of 3	Score of 5
GHG emissions	The project would result in an increase in GHG emissions compared to the baseline.	Project would result in no change to GHG emissions compared to the baseline.	Project would result in a decrease in GHG emissions compared to the baseline.
Beneficial use	No products produced by the project can be beneficially reused at the site or within the community (e.g., power, compost, recycled water).	Some products produced by the project can be beneficially reused at the site or within the community (e.g., power, compost, recycled water).	All products produced by the project can be beneficially reused at the site or within the community (e.g., power, compost, recycled water).
Environmental risk	The project affects ecosystem function or processes related to air, water, or land **and** requires more than 50 acres of land.	The project does not impact ecosystem function or processes related to air, water, or land **and** requires more than 1 acre of land.	The project improves the human impact on ecosystem function or processes related to air, water, or land **and** requires less than 1 acre of land.
Potential for facility co-locations	The facility is sited at an undeveloped site.	The facility site is partially developed (e.g., a transfer station).	The facility is sited at a previously developed site.
Permitting complexity	Highest level of permitting complexity.	Moderate level of permitting complexity.	Lowest level of permitting complexity.

7.3.1 GHG Emissions

GHG emissions were calculated using a mass balance for each alternative. The total gases emitted were then converted into Global Warming Potential. The Global Warming Potential was developed to normalize the global warming impacts of different gases. It measures how much energy the emissions of 1 ton of gas will absorb over time relative to the emissions of 1 ton of carbon dioxide (CO_2). Because some gases like methane and nitrous oxide have a greater warming effect, the emission of those gases would calculate a higher global warming potential compared to the same volume of CO_2 emitted.

Vehicle miles traveled were developed by assuming feedstock generation has a linear relationship to population. Hauling to the facility and hauling within the process were included. Hauling from the facility to the land application or sale for compost was left out of the analysis due to the wide variety of possible land application locations. Table 7-18 includes the results of the vehicle miles, emissions, and total cost based on the potential facility site. Table 7-19 shows the global warming potential based on the alternative.

Table 7-18: Summary of vehicle miles and emissions by facility location

Criteria	Alternative Location			Units
	Bend WRF	Knott Landfill	Redmond	
Total vehicle miles	2,438	1,387	3,445	miles per month
Total CO_2 emissions	2,954	1,680	4,175	kg CO2 per month
Total hauling cost	5,691	3,667	6,792	$ per month

Table 7-19: Summary of calculated global warming potential

Greenhouse Gas	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Biogas Production, MMBtu/year	0	19,589	19,589	19,589	21,373	19,589	19,589
Stationary Combustion CO_2, tons/year	0	1,124	1,124	1,124	1,227	1,124	1,124
Stationary Combustion CH_4, tons/year	0	0.3	0.3	0.3	0.3	0.3	0.3
Stationary Combustion N_2O, tons/year	0	4	4	4	5	4	4
Hauling eCO_2, tons/year	44	27	27	44	44	60	54
Facility eCO_2, tons/year	55	59	77	51	55	59	71
Landfill/land application eCO_2, tons/years	423	0	0	0	0	0	0
Electricity Displacement eCO_2, tons/year	0	-89	-158	-299	-312	-89	-158
Total	467	1,125	1,074	925	1,019	1,159	1,096

Alternative 1 is the baseline and the point of comparison in the scoring criteria. Therefore, it was assigned a score of 3 out of 5. The calculation of the status quo carbon emissions included hauling, emission from landfilled food waste, and a conservative estimation for carbon emissions from land application of FOG. All other alternatives have a higher total global warming potential because the combustion of gas into energy results in greenhouse gas emissions. If combustion into energy was removed from the calculation, the greenhouse gases from the hauling and processing of the wastes in all other alternatives would be less than that of the status quo (Alternative 1) because the air emissions are controlled in the digestion process. In Alternative 1, FOG is applied to fields and food waste is placed in landfills, both will break down over time into GHGs. These are non-point source emissions with limited air emission control. Additionally, Alternative 1 does not generate any benefit from energy recovery. Alternatives 2 through 7 were given a score of four because the processing and hauling of the wastes alone had a lower global warming potential compared to that of Alternative 1, and additionally provide the benefit of energy resource recovery. Figure 7-3 compares the global warming potential, and Table 7-20 shows the final criteria scoring for each alternative.

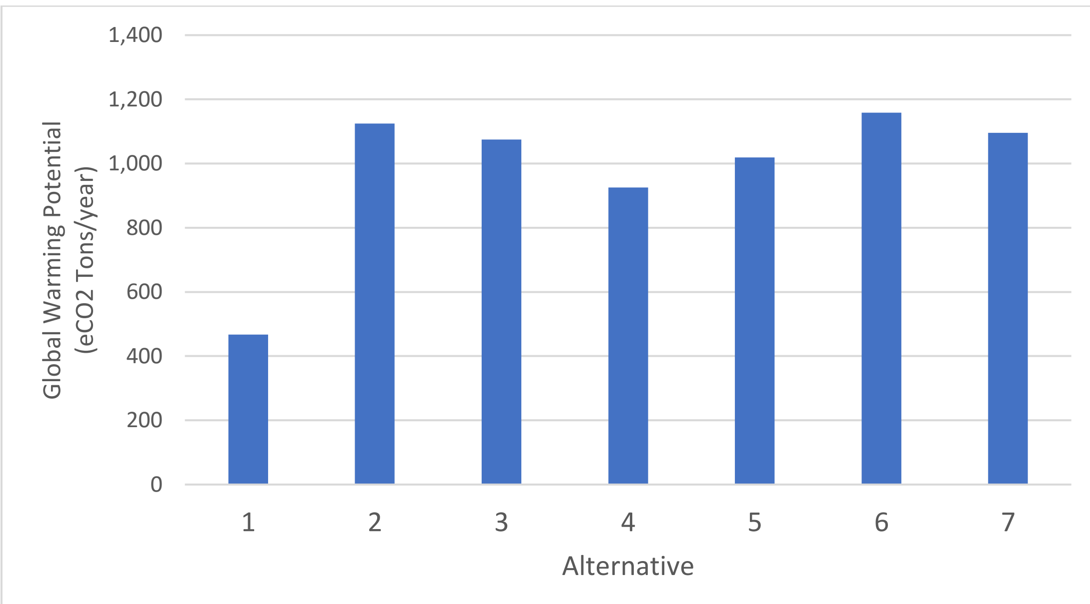

Figure 7-3: Comparison of global warming potential for each alternative

Table 7-20: Scores for the GHG Emissions criterion

TBL – GHG Emissions							
Alternative	1	2	3	4	5	6	7
Score	3	4	4	4	4	4	4

7.3.2 Beneficial Use

Figure 7-4 summarizes the total products produced by each alternative. For Alternative 3 and 7, RNG was converted to kWh/year, assuming a 50% efficiency for conversion of natural gas to energy. A detailed breakdown of alternative product production and product value is included in Appendix G.

The co-digestion alternatives produce the most energy because they capture digester gas from WRF solids and hauled wastes. Alternative 5 produces the most energy, enough to power approximately 500 homes per year. Alternative 3 and 7 produce the most energy out of the organics only digestion alternatives, approximately enough to power 255 homes per year. Alternative 1 produces no energy.

A mix of solids and recycled water is produced by the technologies. The organics only digestion alternatives (2,3, and 6) produce a compost product that can be sold for residential use and allows for the most flexibility of solid product use.

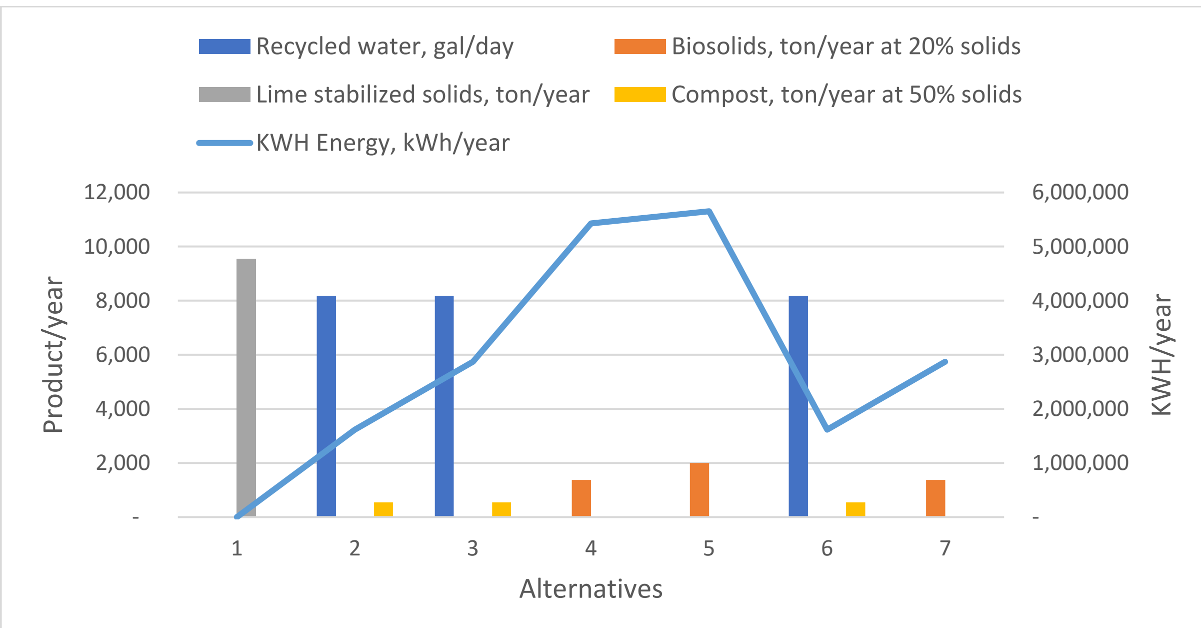

Figure 7-4: Comparison of product production for each alternative

The final TBL score for the beneficial use criterion is found in Table 7-21.

Table 7-21: Scores for the Beneficial Use criterion

TBL – Beneficial Use							
Alternative	1	2	3	4	5	6	7
Score	3	3	4	5	5	3	4

7.3.3 Environmental Risk

Environmental risk could comprise a variety of measures. For this project, the criteria were defined by the following two questions:

1. Does this alternative affect ecosystem functions or processes related to land, water, or air?
2. How much land is required for this alternative?

Table 7-22 summarizes the results of the analysis for environmental risk. For land use, Alternative 1 requires the most due to the acreage required for land applications of lime-stabilized slurries. Alternative 1 requires the application of FOG waste to the soil. FOG is a bad soil amendment and reduces the soil's ability to capture and retain nutrients, degrading the soil over time. Alternatives 2 through 7 have no known impacts on ecosystem function. However, hauling and processing of feedstocks generate GHG emissions.

Table 7-22 Scores for the Environmental Risk criterion

Alternative	1	2	3	4	5	6	7
Land Use, acres	5,052	0	0	90	130	0	90
Impact to ecosystem function	FOG land application impacts soil.	No known impacts.					
Impact to water, air, land	Hauling emissions, potential for contamination from runoff.	Hauling emissions.					
Score	1	5	5	3	3	5	3

7.3.4 Potential for Facility Co-Location

The potential for facility co-location was evaluated based on the facility siting and if there was existing infrastructure that could be utilized, for example, water treatment, natural gas pipelines, or digestion facilities. Table 7-23 provides a summary of the potential for facility co-location and the TBL scores.

The Bend WRF has digestion, solids dewatering, water treatment, and drying beds that can be utilized for co-digestion in Alternatives 4 and 5. The existing digestion and drying bed facilities are undersized for the additional feedstocks, and the capital to upsize the facilities for hauled waste was incorporated into the alternatives' costs. Alternative 7 also assumes the use of the WRF's existing solids dewatering and drying bed infrastructure.

Deschutes County Solid Waste is currently working on a gas capture project at Knott Landfill. After discussions with Deschutes County Solid Waste and Cascade Natural Gas, it was assumed that the gas conditioning infrastructure could be shared between the gas capture and Alternative 3. Additionally, Alternatives 2 and 3 assumed that the County could expand its existing composting infrastructure at the landfill for the project.

The Redmond RV Dump Station is a partially developed site. The land use zoning conforms to the alternative land use, and the site is already being used to receive RV waste. The site is also within the city limits, allowing effluent water from the digestion process to be simply drained into the sanitary sewer. All facilities for Alternative 6 would need to be developed, and thus this site was given a reduced score of 4 out of 5.

Table 7-23: Scores for Site Development Status criterion

Resource	Alternative						
	1	2	3	4	5	6	7
Location	Various	Knott Landfill	Knott Landfill	Bend WRF	Bend WRF	Redmond RV dump	Knott->WWTP
Facility at previously developed site?	Yes, but additional land will be required.	Yes, but the future of the site is uncertain.	Yes, but the future of the site is uncertain.	Yes	Yes	Partially developed site; sewer is available.	Yes, but the future of the site is uncertain.
Score	3	5	5	5	5	4	5

7.3.5 Permitting Complexity

Various regulatory requirements apply to each alternative; some alternatives are more complex than others. The following is a list of permits that may apply:

- Water Pollution Control Facility (WPCF) permit – Required for treated water effluent with no discharge to navigable waters.
- Title V Air permit – Air quality permit for major sources of emissions.
- National Pollution Discharge Elimination System (NPDES) permit - Required for treated water effluent with discharge to navigable waters.
- Recycled Water Management Plan - Required for reuse of treated water from a wastewater treatment process for a beneficial purpose.
- Biosolids Management Plan - Required to reuse the biosolids product of a wastewater treatment process.
- Natural Gas Injection Permitting – Required for the injection of RNG into natural gas pipelines.
- Land use permitting - Required approval before building permits can be issued.
- Oregon Department of Agriculture permit - Required for land application of brewery waste.

Table 7-24 summarizes the permitting requirements for each alternative. Some additional notes by alternative are as follows:

- Alternative 4, 5, and 7 – A Biosolids Management Plan is already in place at the Bend WRF; however, the Biosolids Management Plan would require updating.
- Alternative 2, 3, and 7 –A Recycled Water Management Plan is already in place to reuse landfill leachate for dust control. This plan would require updating.
- Alternative 6 – The Redmond RV Dump Station is located within the city limits; an industrial discharge permit into the city sewer system would be required. The Redmond location has the least complex environmental permitting because of the ability to discharge water to the City's sewer system.

Table 7-24: Scores for the Permitting Complexity criterion

Alternative	1	2	3	4	5	6	7
WPCF Permit	x			x	x		
Title V Air Permit		x	x	x	x	x	x
RNG Injection Permitting			x				x
NPDES Permit							
Recycled Water Management Plan		x	x				
Biosolids Management Plan	x			x	x		x
Land Use Permitting	x	x	x			x	x
ODA Permit for Brewery Waste	x						
Score	4.0	3.0	2.0	3.0	3.0	5.0	1.5

7.4 Summary of Results

The COB RRR Alternatives Analysis TBL results are found in Appendix H. Table 7-25 below summarizes the ranking and final score among alternatives. The Stakeholder Committee was in agreement with the alternatives analysis methodology and final alternatives ranking. It was the consensus that the top three highest-scoring alternatives should be considered in the next stage, the feasibility study. Some stakeholders, in particular the City of Redmond, expressed that they would like Alternative 4 to be included in the feasibility study.

Table 7-25: TBL ranking and scores

Rank	Alternative	Final TBL Score
1	Alternative 5 – Co-Digestion of WAS, FOG, Food, and Brewery Waste, and Septage with Cogeneration at Bend WRF	4.2
2	Alternative 4 – Co-Digestion of WAS, FOG, and Food and Brewery Waste with Cogeneration at Bend WRF	3.8
3	Alternative 3 – Organics Only Digestion with RNG at Knott Landfill	3.4
4	Alternative 6 – Organics Only Digestion with Microturbine at Redmond RV Dump Station	3.3
5	Alternative 7 – Organics Only Digestion at Knott Landfill with RNG and Hauled Digestate to Bend WRF	3.2
6	Alternative 2 – Organics Only Digestion with Microturbine at Knott Landfill	3.2
7	Alternative 1 – Status Quo	2.5

8 Conclusion and Recommendations

The RRR project was intended to evaluate alternatives for managing high-strength hauled waste streams in Central Oregon, providing guidance for the City and regional stakeholders to make informed decisions about the best approach for managing brewery, FOG, septic, and portable toilet waste. This section summarizes the conclusions, recommendations, and next steps based on the analysis.

A thorough stakeholder engagement process solicited input from a diverse group of participants with a vested interest in outcomes. Individual interviews and workshops provided unique perspectives, meaningful dialogue, and collaboration to build consensus for the best solutions.

8.1 Conclusions

Based on stakeholder feedback, the current practice of hauling and land applying brewery waste and FOG is not considered to be a viable long-term solution. Land application sites preferred a slurry that didn't include FOG or brewery waste because of the poor soil amendment and odors, respectively. These two waste streams are energy-dense, allowing for resource recovery if managed differently. Stakeholders and the project team recommend a more sustainable and resilient solution for these and other waste streams for Bend and its surrounding areas.

The RRR Alternatives Analysis was conducted by looking at seven different alternatives, and the results found that the construction of facilities to manage hauled waste streams is cost-effective and beneficial to the environment. Each of the alternatives had slight variations in feedstocks, location, digestion technologies, and product processing. The two main digestion technologies considered were co-digestion, in which high-strength wastes were digested with municipal solids at the WRF, and standalone organics digestion, in which food-grade wastes are digested separately from municipal solids waste streams such as septage, porta potty waste, and WAS.

The following summarizes key findings:

- Many of the alternatives had a simple payback period of under 20 years. Potential outside funding from grants and other incentives could reduce the simple payback period for the three lowest-cost alternatives to under 10 years.
- The Status Quo (Alternative 1) is the least preferable alternative.
- The top-rated alternative (Alternative 5) could generate approximately 15,487 kWh/day, enough energy to power over 500 homes!
- Stand-alone organics digestion facilities and co-digestion facilities could generate an annual net profit of up to $1 M and $1.4 M, respectively. In contrast to the current practice, COB is paying approximately $500,000 annually to a contract operator to manage high-strength wastes.

- All alternatives produced Class A Biosolids or composted soil. These products are great fertilizers and can be sold for profit.
- For all digestion alternatives, food waste from the region was added as a digestion feedstock to allow for more energy resource recovery and the added benefit of diverting food waste from the landfill. Central Oregon could be a state leader in this area, as collecting energy from food waste has not yet been implemented by any Oregon municipality, although a few are in the design phase.

In a series of stakeholder workshops, alternatives were scored using the TBL method. Based on the feedstocks identified, tested, and quantified, the three (3) highest-ranked alternatives are described as follows:

1. **Alternative 5 - Co-Digestion of FOG, Food, Brewery Waste, and Septage with Cogeneration at Bend WRF**. Co-digestion at the Bend WRF would create electric energy. The alternative assumed that 50% of porta potty and septic waste generated in Central Oregon would be diverted from current disposal methods and processed at the Bend WRF. When considering all criteria for alternatives, this concept was the most preferable because it had the fastest return on investment and the best overall social, economic, and environmental outcomes.
2. **Alternative 4 - Co-Digestion of FOG, Food, and Brewery Waste with Cogeneration at Bend WRF**. The co-digestion of these wastes at the Bend WRF would create electric energy. The alternative assumed that private local companies would continue the operation of lime stabilization and land application of all WAS, porta potty, and septic waste.
3. **Alternative 3 – Organics Only Digestion with RNG at Knott Landfill**. In this alternative, food, FOG, and brewery wastes are digested to create RNG, organic compost, and recycled water at a stand-alone organics digestion facility at the Knott Landfill.

   This alternative has the potential for partnership with the natural gas utility on the landfill gas capture project. Deschutes County Solid Waste is in the early stages of negotiating a contract for the gas capture project, and more details on partnership opportunities/ funding will come in time. For example, a partnership with Knott Landfill and Cascade Natural Gas could take advantage of combined feedstocks for additional methane capture.

More work is being completed to confirm the analysis. COB has partnered with Oregon State University to complete a treatability and biogas availability study. The results will help validate calculated gas volumes and gas quality produced through both co-digestion at the Bend WRF or in a regional organics only waste processing facility.

Additional data collection is needed to verify the findings of the alternatives analysis. The project team was able to gather a summary of volumes and characteristics of most feedstocks currently being hauled in Central Oregon. There is the potential to add feedstocks as follows:

- Food waste quantified for the alternatives analysis is only a fraction of the food waste available in Central Oregon. The landfill has a commercial food waste composting program that is at capacity. A regional organics waste processing facility would increase the capacity for food waste diversion, increasing energy production while also freeing up capacity at Knott Landfill. Expanding food waste source separation at commercial businesses and residential homes will increase the diversion of food waste from the landfill to a regional facility.

- Currently, other than Deschutes Brewery, most high-strength and all low-strength brewery waste is discharged to the City's sanitary sewer system and billed a substantially high-strength surcharge to recoup the cost of treatment. Diversion of these waste streams to a regional organics waste processing facility would also free up valuable capacity at the Bend WRF.
- Thirteen private RV dumps discharge to the City of Bend WRF wastewater stream with no billing or regulatory oversight. Many of the discharges may be from visitors or neighboring communities. This is a missed revenue stream that may offset treatment costs through tipping fees. In addition, there are regulatory concerns from the DEQ around unmonitored hauled wastes. Building a public receiving facility will help manage this waste stream and provide a community benefit.

To fully implement an RRR program, a policy framework will be needed that can be implemented across regional boundaries. This framework should include pretreatment regulations, tipping fees, user fees, and associated program costs. Policy development must incentivize resource recovery so that action is taken. Active engagement and input from the Bend RRR Stakeholder Committee has been valuable, and the committee should be retained as part of follow-up investigations and in policy development.

The RRR Alternatives Analysis Project showed that there are more sustainable long-term solutions for regional high-strength wastes. Implementing alternatives will lead to multiple regional benefits that help shift from waste disposal to resource management. The Stakeholder Advisory Committee recommends the City continue to the next phase of RRR Program implementation with the three top alternatives.

8.2 Recommendations and Next Steps

Based on the conclusions presented in Section 8.1, the project team makes the following recommendations with anticipated next steps:

1. The COB should complete a more detailed feasibility study either separately or in conjunction with the upcoming WRF Facilities Plan Update. The following alternatives are recommended to be carried forward for further evaluation in the detailed feasibility study:
    a. Bend WRF co-digestion with 50% septage (Alternative 5)
    b. Bend WRF co-digestion with no septage (Alternative 4)
    c. RNG at Knott Landfill (Alternative 3)
2. Consideration should be given in the detailed feasibility study (in Recommendation 1) for the following:
    - Quantifying feedstocks available for low-strength brewery, food, and RV wastes.

- Investigating potential funding opportunities, including energy development incentive funding and P3s. In particular, Alternative 3 (Organics Only Digestion with RNG at Knott Landfill) has a high potential for P3 to help fund capital costs associated with a regional facility.

3. The COB should continue to partner with Oregon State University to complete feedstock treatability studies to help refine and update energy production estimates for both Bend WRF co-digestion and organics only waste processing facilities.
4. The COB should continue stakeholder engagement through all phases of the RRR Program.
5. The COB should begin working with neighboring communities, industries, and other stakeholders to develop a regional policy framework for the management of hauled waste. The framework can be utilized to incentivize the use of an RRR facility while providing economic benefits to businesses and ratepayers. This policy framework should include a summary of targeted waste streams to be diverted to a regional facility and associated pretreatment requirements and regulations.

9 References

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Appendix A: Stakeholder Register

Regional Resource Recovery Program Stakeholder Register

Stakeholder Name	Business/Group	Title/Role	Stakeholder type	Phone Number	Email	Letter of Support	Stakeholder Committee	Engagement Group	Interview number	Notes
Bryan and Shanna Sproat	2 Springs Ranch and George's Septic Tank Service	Owners/Operators	Waste Disposal Facility	541-480-9606 cell 541-419-3148	georges@bendbroadband.com	no	yes	Primary	1	Agreed to participate
Bob Borlen	Agri-Cycle Inc.	Owner/Operator	Waste Hauler	541 408 6628	bborlen@bendcable.com	no	yes	Primary	2	Agreed to participate
Matt Borlen	Agri-Cycle Inc.	Owner/Operator	Waste Hauler	541-408-5337	borlenbeef@gmail.com	no	no	Primary	2	
Brian Cunnington	Cascade Natural Gas	Industrial Services Manager	Utility	509-734-4539	brian.cunnington@cngc.com	yes	yes	Primary	3	Agreed to participate
Dave Markham	Central Electric Cooperative	President and CEO	Utility	DNA	dmarkham@cec.coop	no	no	secondary	NA	Agreed to participate
Brad Wilson	Central Electric Cooperative	Director of Operations and Engineering	Utility	541-548-2144	bwilson@cec.coop	no	yes	Primary	4	non responsive
Lou Crooks	Central Oregon Brewers Guild	Executive Director	Waste Generator	DNA	COBGINFO@gmail.com	no	yes	Primary	5	non responsive
Ben Hemson	City of Bend	Bend Business Advocate	Agencies	541-388-5529	bhemson@bendoregon.gov	no	NA	NA	NA	Agreed to participate
Cally Whitman	City of Bend	Lab Supervisor	Agencies	541-693-2112	cwhitman@bendoregon.gov	no	NA	NA	NA	Agreed to participate
Cassie Lacy	City of Bend	Senior Management Analyst	Agencies	541-323-8587	Clasy@bendoregon.gov	no	NA	NA	NA	Agreed to participate
Matthew Ziebol	City of Bend	Utility Compliance Tech	Agencies	541-388-5546	mziebol@bendoregon.gov	no	NA	NA	NA	Agreed to participate
Jake Obrist	City of La Pine	Public Works Manager	Agencies	541-419-5625	jobrist@lapineoregon.gov	yes	yes	Primary	6	Agreed to participate
Eric Klann	City of Prineville	Public Works Director	Agencies	541-447-5627	eklann@cityofprineville.com	no	yes	Primary	7	non responsive
Jason Wood	City of Prineville	WW Treatment Plant Supervisor	Agencies	541-280-8656	jwood@cityofprineville.com	no	no	Primary	7	
Orrin Libolt	City of Prineville	Water/Sewer Supervisor	Agencies	541-777-4581	olibolt@cityofprineville.com	no	no	Primary	7	
Corissa Holmes	City of Redmond	Environmental Programs Supervisor	Agencies	541-604-6408	corissa.holmes@redmondoregon.gov	yes	yes	Primary	8	Agreed to participate
Ryan Kirchner	City of Redmond	Waste Water Division Manager	Agencies	541-504-5070	ryan.kirchner@redmondoregon.gov	no	no	Primary	8	Agreed to participate
Paul Bertagna	City of Sisters	Public Works Director	Agencies	541-323-5212	pbertagna@ci.sisters.or.us	no	yes	Primary		Will not participate
Larry Sidor	Crux Fermentation Project	Co-Founder, Master Brewer, CEO	Waste Generator	541-280-7522	larry@cruxfermentation.com	yes	no	Primary	9	Agreed to participate
Mark Fischer	Deschutes Brewery	Director of Brewery Operations	Waste Generator	541-385-5606 X 143	mfischer@deschutesbrewery.com	yes	yes	Primary	10	Agreed to participate
Chad Centola	Deschutes County Department of Solid Waste	Operations Manager	Waste Disposal Facility	541-410-9174	chad.centola@deschutes.org	yes	yes	Primary	11	Agreed to participate
Tim Brownell	Deschutes County Department of Solid Waste	Director of Operations	Waste Disposal Facility	541-317-3177	Tim.Brownell@deschutes.org	no	yes	Primary	11	
Adrea Rodriguez-Lovejoy	Deschutes County Health Department	Environmental Health Specialist II	Agencies	541-385-3249 541-280-1499 cell	adrea.lovejoy@deschutes.org	no	no	Primary	12	Agreed to participate
Emily Freeland	Deschutes County Health Department	Environmental Health Specialist	Agencies	541-383-6717	emily.freeland@deschutes.org	no	no	Primary	12	
Eric Mone	Deschutes County Health Department	Environmental Health Director	Regulator	541-288-6566	eric.mone@deschutes.org	no	yes	Primary	12	Agreed to participate
Don Myll	Economic Development for Central Oregon	Bend Area Director	Other	541-288-3236	don@edcoinfo.com	no	yes	Primary	13	Agreed to participate
Jon Stark	Economic Development for Central Oregon	CEO	Other	541-923-5223	jon@edcoinfo.com	no	no	Primary	13	
Joshua Reed	Energy Trust of Oregon	Renewables Project Manager	Other	503-455-2954	Joshua.Reed@energytrust.org	yes	NA	Primary	NA	
Wym Matthews	Oregon Department of Agriculture	CAFO Program Manager	Agencies	503-986-4792	wym.matthews@oda.oregon.gov	no	yes	Primary	14	Agreed to participate
Rob Delmar	Oregon Department of Energy	Senior Policy Analyst	Agencies	503-302-7027	robert.delmar@energy.oregon.gov	no	yes	Primary	15	non responsive
Estegenet Belete	Oregon Department of Environmental Quality	Pretreatment Coordinator	Agencies	DNA	estegenet.belete@deq.oregon.gov	no	no	Primary	16	
Pat Heins	Oregon Department of Environmental Quality	State Biosolids Coordinator	Agencies	503-229-5749	pat.heins@deq.oregon.gov	no	yes	Primary	16	Agreed to participate
Todd Hesse	Oregon Department of Environmental Quality	Solid Waste Engineer	Agencies	541-261-4167	todd.hesse@deq.oregon.gov	no	no	Primary	16	
Matt Chancellor	Pacific Corp	Regional Business Manager	Other	541-633-2483 541-419-0373 cell	Matthew.Chancellor@pacificorp.com	no	no	Primary		Will not participate
Randy Eckerman	Private Citizen	lives adjacent to land application	Private Citizen	541-410-9049	wreck.randy@gmail.com	no	no	Secondary	NA	
Greg Galindo	South West Water Company (McDonald's Septic)	Vice President of Field Operations	Waste Disposal Facility, Waste Generator	626-890-0797	ggalindo@swwc.com	no	yes	Primary	17	Agreed to participate
Patrick Smith	Sunriver Utilities	Environmental Manager	Agencies	541-593-4197	psmith@sunriverutilities.com	no	yes	Primary	18	Agreed to participate
Cody Banner	Worthy Brewing Company	CEO	Waste Generator	541-729-5754	cody@worthbrewing.com	no	no	Primary	19	Agreed to participate
Rick Martinson	Worthy Brewing/Worthy Garden Club	Executive Director	Waste Generator	541-639-4776 X221 541-948-0661 cell	rick@worthygardenclub.com	no	no	Primary	19	
Gayle Johnson	Abe Jones Septic Service	Owner/Operator	Waste Hauler	541-382-7761	gayle@abejones.com	no	no	Secondary	NA	
Kim Dobbs	Bulldog Septic	Owner/Operator	Waste Hauler	541-306-9974	bulldogseptic@yahoo.com	no	no	Secondary	NA	
Ken Wells	Central Grease and Oil	Owner/Operator	Waste Hauler	541-815-7500	swells@bendbroadband.com	no	yes	Primary	20	Agreed to participate
Rob Fish	Pacific Grease Trap Services	Owner/Operator	Waste Hauler	541-480-4060	pacificgreasetrap@yahoo.com	no	no	Secondary	NA	
Dwight Mohr	Roto-Rooter	Branch Manager	Waste Hauler	541-735-4543	dwight.mohr@rrsc.com	no	no	Secondary	NA	
Dusty Stenkamp	Superior Sanitation Services	Owner/Operator	Waste Hauler	541-480-0300	mucksepticservice@gmail.com	no	no	Secondary	NA	
Lindsey Hardy	Enviornmental Center	Director of Energy and Waste Programs	Other	541-385-6908 x11	lindsey@envirocenter.org	no	no	Primary	21	
Udara (Abeysekera) Bickett	Enviornmental Center	Program Manager	Other	DNA	udara@envirocenter.org	no	yes	Primary	21	Agreed to participate

Appendix B: Stakeholder Engagement Documentation

B.1 Stakeholder Engagement Plan

STAKEHOLDER ENGAGMENT PLAN
Hauled Waste Management Alternatives Analysis [City Project No. XXXXXX]
Prepared: December 2021
Revised:

CITY OF BEND

OVERVIEW

This Stakeholder Engagement Plan will guide involvement and activities during the execution of the Hauled Waste Management Alternatives Analysis Project [HWMAA]. As the project team works to develop and prioritize alternatives, it is important to properly engage and represent key stakeholders within the City of Bend and throughout the greater Central Oregon community. This stakeholder engagement plan outlines proposed strategies to ensure that stakeholders are made aware of the project goals and have an opportunity to provide input in ways that are meaningful. Outreach efforts will be proactive and utilize strategies that both inform and engage key stakeholders.

The HWMAA is intended to identify alternative management solutions for regional hauled wastes that will mitigate the negative impacts and risks of current practices while taking advantage of opportunities provided by other management options. With stakeholder input, the project team will evaluate and make recommendations regarding:

- Increased resource recovery and reuse
- Increased revenue generation
- Decreased costs to ratepayers, governmental agencies, business, and industry
- Increased environmental benefits

The City of Bend has engaged in informal conversations with regional partners for the past several years. The current project team will be responsible for building on these discussions by directing meaningful dialogue and collaboration between stakeholders to encourage shared ownership and facilitate joint decision-making between the City and other regional governments, associations, and business partners.

The City has contracted with Leeway Engineering Solutions to perform a strategic analysis for handling multiple waste streams and provide guidance to the City of Bend and regional stakeholders as to the best course of action to mitigate the economic / environmental impacts of current practices and identify future practices / processes that will lead to resource recovery, increased revenue generation, decreased costs, greenhouse gas reduction, and other environmental benefit.

GUIDING PRINCIPLES FOR STAKEHOLDER ENGAGEMENT

- Provide timely information about project objectives to affected stakeholders and other interested parties.
- Give adequate notice of stakeholder outreach activities and allow time for review and input.
- Information posted to the project website including a description of the evaluation process, schedule, draft / final deliverables as appropriate.
- All input / comments will be documented and the decision-making process will be transparent.
- Public hearings or workshops, if any, will be duly noticed in accordance with applicable requirements.

TARGET AUDIENCE

Internal and external stakeholders involved with collecting, treating, and disposing of hauled waste streams including:

- City of Bend Departments
  - ➢ Utilities (project management team)
  - ➢ City Manager's office
  - ➢ Engineering and Infrastructure Planning
  - ➢ Community Development
  - ➢ Economic Development
  - ➢ Finance
  - ➢ Legal
  - ➢ Procurement

- Bend City Council and Advisory Committees
  - ➢ Environment and Climate Committee
  - ➢ Bend Economic Advisory Board (BEDAB)
  - ➢ Community Building Sub-Committee

- Other Government Agencies
  - ➢ Deschutes County
  - ➢ City of Redmond
  - ➢ City of LaPine
  - ➢ City of Sisters
  - ➢ City of Prineville
  - ➢ Oregon Department of Environmental Quality

- Industry Partners
  - Breweries
  - Waste haulers and landowners
  - Portable toilet companies
  - Restaurants
  - Chambers of Commerce / business associations / EDCO
  - Utilities: Pacific Power and Cascade Natural Gas
  - Energy Trust of Oregon
  - Destination resorts and unincorporated communities

GOALS

- Ensure a collaborative stakeholder engagement process.
- Obtain timely input from key stakeholders.
- Complete the HWMAA prior to the City's Collection System Master Plan (CSMP) update.
- Develop a clear strategy for implementing HWMAA recommendations.

STRATEGY

- Develop relevant and meaningful interview questions and discussion topics.
- Provide advanced notice of requested interview dates, venues, and discussion topics.
- Keep stakeholder feedback / input focused within the scope of the project.
- Provide adequate windows of opportunity for feedback / input.
- Outreach specifically aimed at target audience as identified above.
- Electronically mail information to target audience and other interested parties. Pertinent information will be contained in the subject line to ensure maximum exposure of the information.
- Provide ample opportunities for feedback and input.
- Establish a project website which will be updated and maintained to provide the most current and accurate information available. The website, at a minimum, will contain the following information:
  - Project contact information
  - Frequently asked questions (FAQ's)
  - Project scope and schedule including key milestones
  - Current project status and sign-up form for project notifications
  - Draft and final analysis documents

- ➢ Public meeting information (if any)
- Provide Project updates in the City newsletter and City Manager Memo as appropriate.

KEY MESSAGES

- As Bend and Central Oregon continue to grow, the need for updated hauled waste management practices increases.
- The HWMAA will provide the initial framework and direction for future update efforts.
- This project is an initial first step toward a long-term and collaborative strategy to reduce and reuse certain waste streams throughout the region.
- Project scope will be constrained by budget and schedule.
- HWMAA recommendations will be used to inform City Collection System Master Plan (CSMP) and Water Reclamation Facilities Plan updates.
- Implementation programming, logistics, scope, schedule, and budgets are yet to be determined.
- ***"Bend's infrastructure*** **projects** ***are a long-term investment in our community, focusing on protecting public health and the environment while supporting local economic development and jobs". (Council Goals)***

CITYWIDE MESSAGES (for internal reference)

What we do:

- Plan, design, construct, operate, and maintain the City's utility infrastructure systems.

Who we work for:

- We serve the community by providing infrastructure improvements of enduring quality.

Key words / phrases to incorporate in messaging:

- Reduce and reuse, cost recovery and cost reduction, environmentally friendly, up to date / current, best management practices, appropriate for Bend and Central Oregon, continued improvement / progress.

KNOWN RISKS

- Potential pushback related to increased regulation, program development costs, and long-term affordability.
- Differing wants, needs, and opinions of stakeholders both internal and external to the project team.
- Budgetary and schedule constraints will likely limit the project team's ability to address all issues brought forth.
- Coordination and alignment with other stakeholder practices currently in-place.
- Ability to develop and sustain a coordinated program after completion of the initial evaluation project.

LIST OF COMMUNICATIONS TOOLS and AUDIENCES

COMMUNICATIONS TOOLS	AUDIENCE
Interviews	Affected key stakeholders
City Monthly newsletter	Bend community
Email project updates	Stakeholder Register / Target Audience list, related business registrations, project email list, and others
Meetings	Individuals and affected stakeholders.
Website	All Interested parties
Fact sheet with “Frequently Asked Questions”	All Interested parties
Talking points for City of Bend Staff, project team, and elected officials	All Interested parties

TIMELINE and TACTICS

DATE	COMMUNICATION TACTIC	TARGET AUDIENCE	PERSON RESPONSIBLE	PURPOSE/STATUS
TBD				

TOPICS and SUBJECT MATTER EXPERTS

TOPIC	SPOKESPERSON
Project purpose and benefits	Christina Davenport – City PM
Project purpose and benefits	Mike Buettner
Project purpose and benefits	Jeff England
Project purpose and benefits	Bend City Councilor, TBD
Project scope, schedule, and budget	Christina Davenport
Project technical aspects	Christina Davenport
Project technical aspects	Brittany Park – Consultant PM

B.2 Survey Questions

Regional Resource Recovery Alternatives Analysis Survey - Agencies

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

Who are the known waste generators and waste haulers within your jurisdiction?

Regional Resource Recovery
Alternatives Analysis Survey – Disposal Facilities

What is your business and Central Oregon service area?

Would your company be willing to have hauled waste from your accounts disposed of at a new regional hauled waste management facility?

Would your company be interested in providing collection, separation, and pre-processing of food waste to feed to a new regional facility?

Are you aware of any contracts or other agreements that would impact disposal of hauled waste at a new regional facility?

How much do you currently charge / pay for waste disposal?

What types of waste and volumes of waste do you accept monthly or annually?

Do you have data on the total number of waste truckloads monthly or annually?

Do you have records for volume of waste disposal by source location?

Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:

- **Chemical Oxygen Demand (COD)**
- **Total Suspended Solids (TSS)**
- **Volatile Suspended Solids (VSS)**
- **Grease fines concentration**

Regional Resource Recovery Alternatives Analysis Survey - Utilities

What is the name of the utility you represent and what type of utility service is provided?

How is your utility relevant to hauled waste collection, treatment, and disposal?

What are the biggest challenges your utility currently faces related to hauled waste recovery and reuse?

Is your utility willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

What funding is available from your utility to assist with development and maintenance of a long-term regional resource recovery program in Central Oregon?

Regional Resource Recovery
Alternatives Analysis Survey – Waste Haulers

Interest and Desired Location:

- **Would your company be willing to dispose of hauled waste from your accounts at a new regional hauled waste management facility?**
- **If yes, do you have a preference for the geographic location of this new regional facility. Options currently under consideration are the Bend WRF, Redmond WRF and/or the Deschutes County Landfill? If not, why not?**
- **Would your company be interested in providing collection, separation and pre-processing of food waste to feed to a new regional facility?**
- **Are you aware of any contracts or other agreements that would impact disposal of hauled waste at a new regional facility?**

Hauled Waste Collection (type, volume/quantity and account locations):

- **What do you currently charge for waste hauling?**
- **What is your Central Oregon service area?**
- **What types of waste and volumes do you haul, monthly and annually?**
- **Do you have data on the number of total truckloads, monthly and annually?**
- **Do you have records for volume of hauled waste by source location?**
- **Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:**
  - **Chemical Oxygen Demand (COD)**
  - **Total Suspended Solids (TSS)**
  - **Volatile Suspended Solids (VSS)**
  - **Grease fines concentration**

Hauled Waste Disposal & Tipping Fees:

- **How much do you currently charge for hauling waste on a per gallon or per truckload basis?**
- **How much do you currently pay on a per gallon or per truckload basis for hauled waste disposal?**
- **What are the primary locations where you transport or dispose of hauled waste?**
- **Do you have records for the volume of hauled waste by disposal location?**
- **Would you be willing to pay a tipping fee for disposal at a new regional hauled waste facility?**
- **If yes, do you have a potential range on a $/gallon basis you would be willing to pay?**
- **Would you be willing to submit a proposal for disposing hauled waste at a new Central Oregon regional facility?**

Regional Resource Recovery Alternatives Analysis Survey - Businesses

What is your business?

What are the biggest challenges you currently face related to hauled waste treatment and disposal?

What hauled waste streams are you currently generating and how are they being disposed of?

What do you currently spend for waste hauling per month or annually?

What types of waste and volumes of waste do you generate per month or annually?

Do you have data on the number of total truck loads per month or annually?

Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:

- **Chemical Oxygen Demand (COD)**
- **Total Suspended Solids (TSS)**
- **Volatile Suspended Solids (VSS)**
- **Grease fines concentration**

Would your business be willing to participate in developing a program for regional resource recovery which may include collection, processing, recovery, reuse, and disposal of hauled wastes? If so, how much would your business be willing to spend per month or annually to develop and maintain a long-term regional resource recovery program in Central Oregon?

B.3 Survey Responses

Regional Resource Recovery Alternatives Analysis Survey - Businesses

What is your business?

Deschutes Brewery

What are the biggest challenges you currently face related to hauled waste treatment and disposal?

Uncertainty in use of permitted land for land application. Cost of hauling waste. Availability of land within reasonable distance from brewery.

What hauled waste streams are you currently generating and how are they being disposed of?

Brewery high strength waste is stored in tanks and hauled by local contractor, Agricyle to farms for land application as fertilizer.

What do you currently spend for waste hauling per month or annually?

$233,000/year cost to haul waste.

What types of waste and volumes of waste do you generate per month or annually?

4,328,000 gallons / year (2021). At build out of brewery, could go to 7,869,000 gallons/year.

Do you have data on the number of total truck loads per month or annually?

1,082 truck loads / year (2021). At full build out of brewery could go to 1,970 truck/year.

Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:

- **Chemical Oxygen Demand (COD)**
- **Total Suspended Solids (TSS)**
- **Volatile Suspended Solids (VSS)**
- **Grease fines concentration**

COD 90,630 mg/l average of 10 samples from 2015. Range 39,900 - 122,000 mg/l.
TSS 31,832 mg/l average of same. Range 2,820 - 59,600 mg/l.
VSS 97.28% by weight TS average of same. Range 93.3% - 100%.

Would your business be willing to participate in developing a program for regional resource recovery which may include collection, processing, recovery, reuse, and disposal of hauled wastes? If so, how much would your business be willing to spend per month or annually to develop and maintain a long-term regional resource recovery program in Central Oregon?

We would be willing to participate in the design, coordination of a facility. Depending on size zoning and neighborhood restrictions, a small parcel of land might be available for a facility.
Financial resources may be available.

Regional Resource Recovery Alternatives Analysis Survey - Agencies

Response: DEQ Pat Heins

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

Receiving facility must have a valid water quality permit from DEQ and an up to date hauled waste plan.

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

There are currently no planed changes to DEQ's hauled waste program.

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

While DEQ does encourage long-term regional resource recovery programs, my participation in this group is not to be inferred as DEQ's endorsement of this project or any alternative identified in this process. As a state regulatory agency, I can only provide information on our regulations and programs. Once the plan is developed we can only review and approve/deny proposed applications.

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

DEQ does administer the state revolving fund program which offers funding options however my participation in this group will have no bearing on any application this group may or may not submit to the revolving fund program.

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

Who are the known waste generators and waste haulers within your jurisdiction?

Regional Resource Recovery
Alternatives Analysis Survey - Agencies

Response: City of La Pine

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

From the City of La Pines perspective, septage waste is a concern because we do not have very many options for disposal. We curently do not handle FOG waste because our facility cannot handle it properly.

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

Unknown

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Yes

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

Unknown

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

Unknow at this time

Who are the known waste generators and waste haulers within your jurisdiction?

Republic and numerous septage haulers.

Regional Resource Recovery Alternatives Analysis Survey - Agencies

Response: DEQ Todd Hesse

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

I (Todd Hesse) have been in DEQ's solid waste program since 2020 and don't have much direct experience with hauled waste from my time with DEQ water quality. I suspect the main issues with hauled waste are 1) unlicensed haulers, 2) improper or illegal disposal and 3) WWTPs accepting hauled waste amounts or types that may not be appropriate to the type or capacity of the treatment plants or 4) WWTPs not having the required hauled waste plan in place.

DEQ has a document on preparing hauled waste plans here that might be of interest - https://www.oregon.gov/deq/FilterDocs/HauledWasteDEQACWA2015.pdf. This document on the top of page 2 discusses NPDES permit requirements for a hauled waste plan. I suspect that Water Pollution Control Facilities Permits (no discharge to surface water) also have language in the permit schedules requiring a hauled waste plan.

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

I am not aware of any planned changes to the regulatory requirements for hauled wastes.

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Yes, some staff from DEQ are willing to participate.

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

I don't know. Greg Sveulnd, DEQ Region Solutions, who plans to attend the 03/09 meeting may be able to assist with that question.

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

DEQ would not be an appropriate agency for siting or operating a new hauled waste facility, but would be willing (I believe) to provide some technical assistance. DEQ does not make land use decisions, but requires an affirmative Land Use Compatibility Statement from the governing land use planning authority (typically city or county) as part of the permit application process.

Who are the known waste generators and waste haulers within your jurisdiction?

Homeowners with septic tanks are the generators I am most familiar with, with licensed haulers taking pumped septage to WWTPs willing to accept it. I think the DEQ onsite program (contacts page - https://www.oregon.gov/deq/Residential/Pages/Onsite-Contacts.aspx) tracks licenses for haulers of this type of waste. DEQ staff participating in the call could reach out to other DEQ staff to gather more information if that would be helpful.

Regional Resource Recovery Alternatives Analysis Survey - Agencies

Response: Deschutes County Public Health Department

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

My agency only has jurisdiction over waste streams when they are in the facility where they originate. Once they are hauled and/or removed from the facility, my agency does not have jurisdiction.

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

No regulatory changes are anticipated. No timing or cost implications.

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Yes

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

Our staff would be available to consult on environmental health related issues during the development and maintenance of a regional resource recovery program in Central Oregon.

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

My agency does not have the capacity to site and operate a new hauled waste management facility.
However, I strongly recommend managing brewery waste through conversion of organic waste into protein biomass using black soldier flies, and would be able to support the development of this process. Brewery by-products are an efficient rearing substrate for BSF mass production, the waste streams convert waste nutrients into biomass that can be used as protein ingredient for livestock feed, and residues from BSF can be used as organic fertilizer. This process has successfully been implemented throughout the US and the world and has been shown to generate revenue, improve environmental benefits and improve resource recovery and reuse.

Who are the known waste generators and waste haulers within your jurisdiction?

Republic Services. Cascade Disposal.

Regional Resource Recovery
Alternatives Analysis Survey - Agencies

Response: Deschutes County Solid Waste

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

From what I gather from the project website, the focus of your effort is "hauled waste streams" (fats, oils, greases, brewery waste and septic/portable toilet waste). None of these waste types are accepted at Knott Landfill and do not have an impact operationally or with regulatory concerns for us.

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

No changes in our permits/policies to allow hauled waste streams are anticipated.

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Deschutes County is embarking on a landfill siting effort and if some sort of biodigester or similar technology were to be considered for hauled waste streams, the new landfill site could be a potential host location.

If greenwaste (vegetation) were to be considered feedstock for a hauled waste stream management facility, Deschutes County might have some interest. In particular, as an outlet for fire mitigation debris for defensible space on private property.

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

That has yet to be determined.

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

See question #3.

Who are the known waste generators and waste haulers within your jurisdiction?

We manage all municipal solid waste generated in Deschutes County (residential, commercial, industrial, construction/demolition).

Waste haulers include the general public, contractors and the two franchise waste collection companies in Deschutes County, Waste Connections and Republic Services.

Regional Resource Recovery
Alternatives Analysis Survey - Agencies

Response: Oregon Department of Agriculture

What are the current regulatory issues / requirements from your agency related to hauled waste streams in Central Oregon?

Agricultural land application of agricultural waste and solid waste. ORS 468B.025

CAFO Facility permitting and compliance. ORS 468B.050, 468B.215 and OAR 603-074

Fertilizer and Soil amending materials registration. ORS 633.311 to .479 and OAR 603-059

What regulatory changes are anticipated?
What are the timing and cost implications of these changes?

None at this time.

Is your agency willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Yes

What funding is available from your agency to assist with development and maintenance of a regional resource recovery program in Central Oregon?

1-Up to $70,000.00/yr for fertilizer research to protect surface and ground waters.

2-CAFO Fine Fund for research that provides information to CAFO operators about crop nutrient management or nutrient treatment and recovery systems.

Cities: Would your agency be willing to consider siting and operating a new hauled waste management facility? If so what type and where?

No

Who are the known waste generators and waste haulers within your jurisdiction?

CAFOs
Food Processors
Wineries
Beer Production
Composters

Regional Resource Recovery Alternatives Analysis Survey - Utilities

Response: Cascade Natural Gas

What is the name of the utility you represent and what type of utility service is provided?

Cascade Natural Gas Corp a Subsidiary of MDU Resources Company, LLC. We provides Natural Gas Service to Central Oregon Communities.

How is your utility relevant to hauled waste collection, treatment, and disposal?

Cascade is interested in Landfill gas (RNG) to convert into pipeline quality gas for our customers in the Bend area.

Also, Cascade is interested in providing Compressed Natural Gas as a fuel if the City and/or County was interested in upgrading any of their vehicles.

What are the biggest challenges your utility currently faces related to hauled waste recovery and reuse?

State and Federal regulation that are subject to change within the utility business.

Is your utility willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

Cascade Natural is looking to participate in a program that is beneficial to its customers, the community and the environment.

What funding is available from your utility to assist with development and maintenance of a long-term regional resource recovery program in Central Oregon?

I am unaware of any at this time. This will need to reexamined at another time.

Regional Resource Recovery Alternatives Analysis Survey - Utilities

Response: Sunriver

What is the name of the utility you represent and what type of utility service is provided?

Sunriver Utilities; Water / Waste Water.

How is your utility relevant to hauled waste collection, treatment, and disposal?

Sunriver Environmental Hauls Screenings / Fog To The Landfill.

What are the biggest challenges your utility currently faces related to hauled waste recovery and reuse?

Cost.

Is your utility willing to participate in the development and maintenance of a long-term regional resource recovery program in Central Oregon?

What funding is available from your utility to assist with development and maintenance of a long-term regional resource recovery program in Central Oregon?

Regional Resource Recovery
Alternatives Analysis Survey – Waste Haulers

Response: Pacific Grease Trap

Interest and Desired Location:

- **Would your company be willing to dispose of hauled waste from your accounts at a new regional hauled waste management facility?**
- **If yes, do you have a preference for the geographic location of this new regional facility. Options currently under consideration are the Bend WRF, Redmond WRF and/or the Deschutes County Landfill? If not, why not?**
- **Would your company be interested in providing collection, separation and pre-processing of food waste to feed to a new regional facility?**
- **Are you aware of any contracts or other agreements that would impact disposal of hauled waste at a new regional facility?**

No, I need someone to dispose for me

I am not interested in pre-processing because DEQ permitting would be impossible.

I'm not aware of any agreements or contracts.

Hauled Waste Collection (type, volume/quantity and account locations):

- **What do you currently charge for waste hauling?**
- **What is your Central Oregon service area?**
- **What types of waste and volumes do you haul, monthly and annually?**
- **Do you have data on the number of total truckloads, monthly and annually?**
- **Do you have records for volume of hauled waste by source location?**
- **Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:**
  - **Chemical Oxygen Demand (COD)**
  - **Total Suspended Solids (TSS)**
  - **Volatile Suspended Solids (VSS)**
  - **Grease fines concentration**

What I charge is not relevant at this time.

I currently service all of Central Oregon.

I currently collect between 400 and 900 gallons of FSE, HGI interceptors weekly, and utilize another Septic Hauler to dispose of it.

<u>Hauled Waste Disposal & Tipping Fees:</u>

- **How much do you currently charge for hauling waste on a per gallon or per truckload basis?**
- **How much do you currently pay on a per gallon or per truckload basis for hauled waste disposal?**
- **What are the primary locations where you transport or dispose of hauled waste?**
- **Do you have records for the volume of hauled waste by disposal location?**
- **Would you be willing to pay a tipping fee for disposal at a new regional hauled waste facility?**
- **If yes, do you have a potential range on a $/gallon basis you would be willing to pay?**
- **Would you be willing to submit a proposal for disposing hauled waste at a new Central Oregon regional facility?**

I'm very concerned of the potential derailing and mis-application of the program. I have the impression that the Regional Facility will eventually be designed, built, and operated by a government agency and eventually become a monopoly for the disposal of all septic / FOG material. This will eliminate Free Market competition, raise costs, and reduce service quality, thereby adversely affecting the local economy in the same manner as did the attack on logging in the early 1980's.

That's my personal opinion, and thank you for your time.

Robert Fish, Pacific Grease Trap Services.

Ken Wells
Central Grease & Oil

Regional Resource Recovery
Alternatives Analysis Survey – Waste Haulers

Interest and Desired Location:

- Would your company be willing to dispose of hauled waste from your accounts at a new regional hauled waste management facility? YES / Possible –
- If yes, do you have a preference for the geographic location of this new regional facility. Options currently under consideration are the Bend WRF, Redmond WRF and/or the Deschutes County Landfill? If not, why not? NO
- Would your company be interested in providing collection, separation and pre-processing of food waste to feed to a new regional facility? Possible
- Are you aware of any contracts or other agreements that would impact disposal of hauled waste at a new regional facility? NO

City Bend / Redmond requires
G. Trap cleaning & freq. sch.
City should help on disposal

<u>Hauled Waste Collection (type, volume/quantity and account locations):</u>

- **What do you currently charge for waste hauling?** —
- **What is your Central Oregon service area?**
- **What types of waste and volumes do you haul, monthly and annually?**
- **Do you have data on the number of total truckloads, monthly and annually?**
- **Do you have records for volume of hauled waste by source location?** NO
- **Do you have any data or information on hauled waste characterization by concentration (e.g. mg/l)? For example:**
  - **Chemical Oxygen Demand (COD)** —
  - **Total Suspended Solids (TSS)** —
  - **Volatile Suspended Solids (VSS)** —
  - **Grease fines concentration** Possible

Bend, Redmond, Sisters, Sunriver, Lapine. Prineville, Eagle Crest

13,000 monthly + Grease trap
5,000 monthly Cooking Oil

200 small G.Traps month
5 large G. Interceptor month

Hauled Waste Disposal & Tipping Fees:

- How much do you currently charge for hauling waste on a per gallon or per truckload basis? charge by the trap -
- How much do you currently pay on a per gallon or per truckload basis for hauled waste disposal? 11¢ per gal
- What are the primary locations where you transport or dispose of hauled waste?
- Do you have records for the volume of hauled waste by disposal location? Yes
- Would you be willing to pay a tipping fee for disposal at a new regional hauled waste facility? NO
- If yes, do you have a potential range on a $/gallon basis you would be willing to pay?
- Would you be willing to submit a proposal for disposing hauled waste at a new Central Oregon regional facility? ??

2 springs Ranch Crook Co landfill

Appendix C: Hauling Contours

WEST YOST - P:\Clients\1007 Leeway Engineering Solutions\50-22-01 Bend RRR Alts\GIS\MXD\Bend_Hauling_Contour.mxd - aretzlaff - 7/8/2022

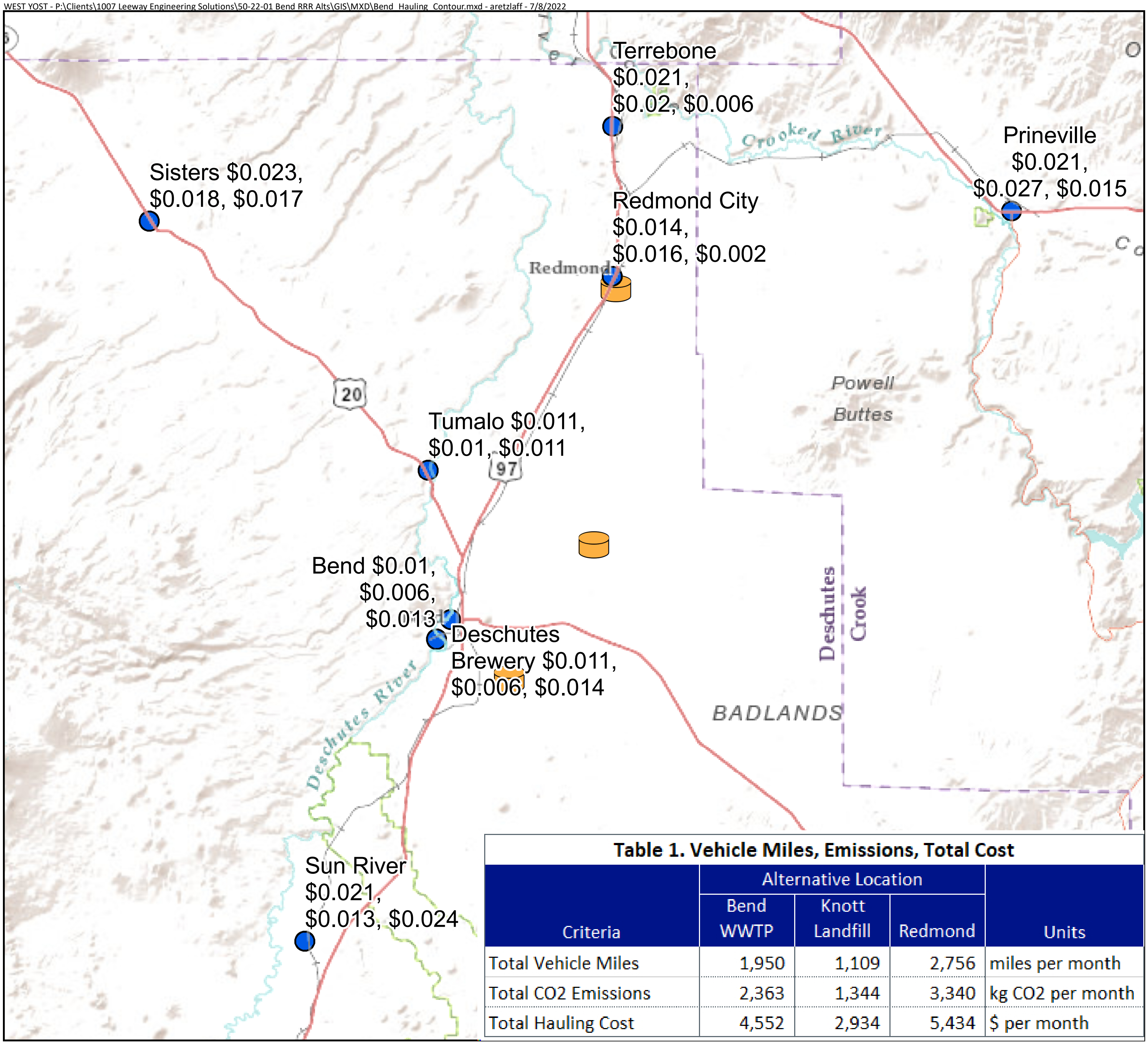

Table 1. Vehicle Miles, Emissions, Total Cost				
	Alternative Location			
Criteria	Bend WWTP	Knott Landfill	Redmond	Units
Total Vehicle Miles	1,950	1,109	2,756	miles per month
Total CO2 Emissions	2,363	1,344	3,340	kg CO2 per month
Total Hauling Cost	4,552	2,934	5,434	$ per month

Hauling Location ($/gal to Bend WWTP, $/gal to Knott Landfill, $/gal to Redmond)

Alternative Location for Hauled Waste Treatment

Notes:
1. Table 1 assumptions:
   a. 5,000 gallon trucks
   b. 8.4 miles per gallon
   c. 1.018 kg CO2 per gallon diesel
   d. $0.625/mi 2022 IRS Standard Milage Rate
   e. $60/hr labor
   f. Roundtrip mileage and time to each location
2. Bend WWTP Address: 22395 McGrath Rd, Bend, OR 97701
3. Knott Landfill Address: 61050 SE 27th St, Bend, OR 97702

WEST YOST

Figure 1

Hauled Waste Contour Map Cost to Bend WWTP

City of Bend
Bend Hauled Waste
Alternatives Analysis Project

Appendix D: Cost Summary and Tipping Fees

Cost Summary and Tipping Fee Sensitivity Analysis

	Alternative 1 - Lime Stabilization and Application			Alternative 2 - Cogen at Knott Landfill		
	$0.11/gal	$0.20/gal	$0.30/gal	$0.11/gal	$0.20/gal	$0.30/gal
O&M Costs, $/year	$ -	$ -	$ -	$ 214,197	$ 214,197	$ 214,197
Tipping Fee Revenue, $/year	$ 607,130	$ 1,103,873	$ 1,655,809	$ 607,130	$ 1,103,873	$ 1,655,809
Solids Products Revenue, $/year	$ -	$ -	$ -	$ 19,250	$ 19,250	$ 19,250
Power Revenue, $/year	$ -	$ -	$ -	$ 92,125	$ 92,125	$ 92,125
Gas Revenue, $/year	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 607,130	$ 1,103,873	$ 1,655,809	$ 504,308	$ 1,001,050	$ 1,552,987
Capital Cost, $	$ -	$ -	$ -	$ 25,070,000	$ 25,070,000	$ 25,070,000
Payback period, years				50	25	16

	Alternative 3 - CNG at Knott Landfill			Alternative 4 - Codigestion at WWTP		
	$0.11/gal	$0.20/gal	$0.30/gal	$0.11/gal	$0.20/gal	$0.30/gal
O&M Costs, $/year	$ 237,445	$ 237,445	$ 237,445	$ 267,277	$ 267,277	$ 267,277
Tipping Fee Revenue, $/year	$ 607,130	$ 1,103,873	$ 1,655,809	$ 607,130	$ 1,103,873	$ 1,655,809
Solids Products Revenue, $/year	$ 19,250	$ 19,250	$ 19,250	$ -	$ -	$ -
Power Revenue, $/year	$ -	$ -	$ -	$ 309,426	$ 309,426	$ 309,426
Gas Revenue, $/year	$ 278,956	$ 278,956	$ 278,956	$ -	$ -	$ -
Total	$ 667,890	$ 1,164,633	$ 1,716,569	$ 649,279	$ 1,146,022	$ 1,697,958
Capital Cost, $	$ 20,670,000	$ 20,670,000	$ 20,670,000	$ 12,200,000	$ 12,200,000	$ 12,200,000
Payback period, years	31	18	12	19	11	7

	Alternative 5 - Codigestion with Septage at WWTP			Alternative 6 - Cogen at Redmond RV Dump Station		
	$0.11/gal	$0.20/gal	$0.30/gal	$0.11/gal	$0.20/gal	$0.30/gal
O&M Costs, $/year	$ (46,641)	$ (46,641)	$ (46,641)	$ 214,197	$ 214,197	$ 214,197
Tipping Fee Revenue, $/year	$ 1,047,895	$ 1,905,263	$ 2,857,894	$ 607,130	$ 1,103,873	$ 1,655,809
Solids Products Revenue, $/year	$ -	$ -	$ -	$ 19,250	$ 19,250	$ 19,250
Power Revenue, $/year	$ 322,211	$ 322,211	$ 322,211	$ 92,125	$ 92,125	$ 92,125
Gas Revenue, $/year	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 1,416,746	$ 2,274,115	$ 3,226,746	$ 504,308	$ 1,001,050	$ 1,552,987
Capital Cost, $	$ 15,180,000	$ 15,180,000	$ 15,180,000	$ 25,070,000	$ 25,070,000	$ 25,070,000
Payback period, years	11	7	5	50	25	16

Cost Summary and Tipping Fee Sensitivity Analysis

	Alternative 7 - Cogen at Knott Landfill, Haul Digestate to WWTP		
	$0.11/gal	$0.20/gal	$0.30/gal
O&M Costs, $/year	$ 340,763	$ 340,763	$ 340,763
Tipping Fee Revenue, $/year	$ 607,130	$ 1,103,873	$ 1,655,809
Solids Products Revenue, $/year	$ -	$ -	$ -
Power Revenue, $/year	$ -	$ -	$ -
Gas Revenue, $/year	$ 278,956	$ 278,956	$ 278,956
Total	$ 545,323	$ 1,042,066	$ 1,594,002
Capital Cost, $	$ 15,660,000	$ 15,660,000	$ 15,660,000
Payback period, years	29	15	10

Appendix E: Capital Costs

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: **Alternative 2**
Organics Only Digestion with Microturbine at Knott Landfill
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder/rock trap	1	EA	$44,100	$44,100	$11,000	$11,000	55,100
Receiving Tank	1	EA	$104,150	$104,150	$26,000	$26,000	130,150
Insulation and heat tracing	1	EA	$17,320	$17,320	$4,300	$4,300	21,620
Mixing pumps	1	EA	$39,735	$39,735	$9,900	$9,900	49,635
Digester feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Digestion							
Digester tank and mixing system	1	EA	$969,000	$969,000	$242,250	$242,250	1,211,250
Digester heating system	1	EA	$82,625	$82,625	$25,000	$25,000	107,625
Solids Processing							
Solids dewatering canopy structure	1000	SF	$200	$200,000	$50	$50,000	250,000
Centrifuge	1	EA	$467,000	$467,000	$116,750	$116,750	583,750
Concrete composting pad	271	CY	$450	$121,767	$250	$67,648	189,415
Push wall (6ft)	58	CY	$450	$26,100	$250	$14,500	40,600
Mixer	1	LS	$50,000	$50,000	$15,000	$15,000	65,000
Trommel screen	1	LS	$260,000	$260,000	$78,000	$78,000	338,000
Gore covers for composting system	1	LS	$600,000	$600,000	$900,000	$900,000	1,500,000
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Recycled Water							
Recycled water treatment package	1	EA	$600,000	$600,000	$150,000	$150,000	750,000
Drainage sump station	1	EA	$15,000	$15,000	$3,750	$3,750	18,750
Biogas Processing							
Waste gas flare	1	EA	$60,000	$60,000	$15,000	$15,000	75,000
Gas conditioning/treatment system	1	EA	$200,000	$200,000	$50,000	$50,000	250,000
Microturbine	2	EA	$370,000	$740,000	$92,500	$185,000	925,000
SUBTOTAL							**$6,748,495**
Site Fencing, Paving, Grading, and Yard Piping			20%				$1,349,699
Mechanical and Piping			20%				$1,349,699
Electrical, Instrumentation, and Controls			20%				$1,349,699
SUBTOTAL							**$10,797,592**
Tax on Materials			0%				$0

Contractor's Markup on Sub-Contractors' Work	10%	$609,650
Contractor's General Conditions, Mob/Demob	15%	$1,620,000
Contractor's Overhead and Profiit	20%	$2,160,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$15,190,000**
Project Contingency	40%	**$6,076,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	25%	**$3,800,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST		**$25,070,000**

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: Alternative 3
Organics Only Digestion with RNG at Knott Landfill
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder	1	EA	$44,100	$44,100	$11,000	$11,000	55,100
Receiving Tank	1	EA	$104,150	$104,150	$26,000	$26,000	130,150
Insulation and heat tracing	1	EA	$17,320	$17,320	$4,300	$4,300	21,620
Mixing pumps	1	EA	$39,735	$39,735	$9,900	$9,900	49,635
Digester feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Digestion							
Digester tank and mixing system	1	EA	$969,000	$969,000	$242,250	$242,250	1,211,250
Digester heating system	1	EA	$82,625	$82,625	$25,000	$25,000	107,625
Solids Processing							
Solids dewatering canopy structure	1000	SF	$200	$200,000	$50	$50,000	250,000
Centrifuge	1	EA	$467,000	$467,000	$116,750	$116,750	583,750
Concrete composting pad	271	CY	$450	$121,767	$250	$67,648	189,415
Push wall (6ft)	58	CY	$450	$26,100	$250	$14,500	40,600
Mixer	1	LS	$50,000	$50,000	$15,000	$15,000	65,000
Trommel screen	1	LS	$260,000	$260,000	$78,000	$78,000	338,000
Gore covers for composting system	1	LS	$600,000	$600,000	$900,000	$900,000	1,500,000
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Recycled Water							
Recycled water treatment package	1	EA	$600,000	$600,000	$150,000	$150,000	750,000
Drainage sump station	1	EA	$15,000	$15,000	$3,750	$3,750	18,750
Biogas Processing							
Waste gas flare	1	EA	$60,000	$60,000	$15,000	$15,000	75,000
SUBTOTAL							**$5,573,495**
Site Fencing, Paving, Grading, and Yard Piping			20%				$1,114,699
Mechanical and Piping			20%				$1,114,699
Electrical, Instrumentation, and Controls			20%				$1,114,699
SUBTOTAL							**$8,917,592**
Tax on Materials			0%				$0
Contractor's Markup on Sub-Contractors' Work			10%				$492,150
Contractor's Overhead and Profit, Mob/Demob			15%				$1,338,000

Contractor's General Conditions	20%	$1,784,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$12,530,000**
Project Contingency	40%	**$5,012,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	25%	**$3,130,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST		**$20,670,000**

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: Alternative 4
Co-Digestion of WAS, FOG, Food, and Brewery Waste with Cogeneration at Bend WWTP
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder	1	EA	$42,200	$42,200	$10,600	$10,600	52,800
Receiving Tank	1	EA	$104,150	$104,150	$26,000	$26,000	130,150
Insulation and heat tracing	1	EA	$17,320	$17,320	$4,300	$4,300	21,620
Mixing system	1	EA	$39,735	$39,735	$9,900	$9,900	49,635
Digester feed pumps	2	EA	$37,500	$75,000	$9,375	$18,750	93,750
Digestion							
Concrete digester (partial capacity)	1	EA	$362,500	$362,500	INCL.	INCL.	362,500
Digester heating system (partial)	1	EA	$49,500	$49,500	$12,400	$12,400	61,900
Digester mixing system (partial)	1	EA	$87,500	$87,500	$26,250	$26,250	113,750
Digester gas safety equipment (partial)	1	EA	$34,375	$34,375	$10,300	$10,300	44,675
Solids Processing							
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Asphalt pavement	125,000	SF	$2	$250,000	$1	$125,000	375,000
Biogas Processing							
Gas conditioning/treatment system	1	EA	$503,500	$503,500	$125,875	$125,875	629,375
Cogeneration engine	1	EA	$1,250,000	$1,250,000	$312,500	$312,500	1,562,500
SUBTOTAL							**$3,591,455**
Plant Paving, Grading, and Yard Piping			5%				$179,573
Mechanical and Piping			20%				$718,291
Electrical, Instrumentation, and Controls			20%				$718,291
SUBTOTAL							**$5,207,610**
Tax on Materials			0%				$0
Contractor's Markup on Sub-Contractors' Work			10%				$360,907
Contractor's Overhead and Profit, Mob/Demob			15%				$781,000
Contractor's General Conditions			20%				$1,042,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$7,390,000**
Project Contingency			40%				**$2,956,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			25%				**$1,850,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$12,200,000**

WEST YOST

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: Alternative 5
Co-Digestion of WAS, FOG, Food, Brewery Waste, and Septage with Cogeneration at Bend WWTP
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder	1	EA	$42,200	$42,200	$10,600	$10,600	52,800
Receiving Tank	1	EA	$104,150	$104,150	$26,000	$26,000	130,150
Insulation and heat tracing	1	EA	$17,320	$17,320	$4,300	$4,300	21,620
Mixing system	1	EA	$39,735	$39,735	$9,900	$9,900	49,635
Digester feed pumps	2	EA	$37,500	$75,000	$9,375	$18,750	93,750
Digestion							
Concrete digester	1	EA	$906,250	$906,250	INCL.	INCL.	906,250
Digester heating system	1	EA	$123,600	$123,600	$30,900	$30,900	154,500
Digester mixing system	1	EA	$218,750	$218,750	$65,625	$65,625	284,375
Digester gas safety equipment	1	EA	$85,938	$85,938	$25,800	$25,800	111,738
Solids Processing							
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Asphalt pavement	125,000	SF	$2	$250,000	$1	$125,000	375,000
Biogas Processing							
Gas conditioning/treatment system	1	EA	$503,500	$503,500	$125,875	$125,875	629,375
Cogeneration engine	1	EA	$1,250,000	$1,250,000	$312,500	$312,500	1,562,500
SUBTOTAL							**$4,465,493**
Plant Paving, Grading, and Yard Piping			5%				$223,275
Mechanical and Piping			20%				$893,099
Electrical, Instrumentation, and Controls			20%				$893,099
SUBTOTAL							**$6,474,964**
Tax on Materials			0%				$0
Contractor's Markup on Sub-Contractors' Work			10%				$458,454
Contractor's Overhead and Profit, Mob/Demob			15%				$971,000
Contractor's General Conditions			20%				$1,295,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$9,200,000**
Project Contingency			40%				**$3,680,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			25%				**$2,300,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$15,180,000**

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: Alternative 6
Organics Only Digestion with Microturbine at Redmond RV Dump
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder	1	EA	$44,100	$44,100	$11,000	$11,000	55,100
Receiving Tank	1	EA	$104,150	$104,150	$26,000	$26,000	130,150
Insulation and heat tracing	1	EA	$17,320	$17,320	$4,300	$4,300	21,620
Mixing pumps	1	EA	$39,735	$39,735	$9,900	$9,900	49,635
Digester feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Digestion							
Digester tank and mixing system	1	EA	$969,000	$969,000	$242,250	$242,250	1,211,250
Digester heating system	1	EA	$82,625	$82,625	$25,000	$25,000	107,625
Solids Processing							
Solids dewatering canopy structure	1000	SF	$200	$200,000	$50	$50,000	250,000
Centrifuge	1	EA	$467,000	$467,000	$116,750	$116,750	583,750
Concrete composting pad	271	CY	$450	$121,767	$250	$67,648	189,415
Push wall (6ft)	58	CY	$450	$26,100	$250	$14,500	40,600
Mixer	1	LS	$50,000	$50,000	$15,000	$15,000	65,000
Trommel screen	1	LS	$260,000	$260,000	$78,000	$78,000	338,000
Gore covers for composting system	1	LS	$600,000	$600,000	$900,000	$900,000	1,500,000
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Recycled Water							
Recycled water treatment package	1	EA	$600,000	$600,000	$150,000	$150,000	750,000
Drainage sump station	1	EA	$15,000	$15,000	$3,750	$3,750	18,750
Biogas Processing							
Waste gas flare	1	EA	$60,000	$60,000	$15,000	$15,000	75,000
Gas conditioning/treatment system	1	EA	$200,000	$200,000	$50,000	$50,000	250,000
Microturbine	2	EA	$370,000	$740,000	$92,500	$185,000	925,000
SUBTOTAL							**$6,748,495**
Site Fencing, Paving, Grading, and Yard Piping			20%				$1,349,699
Mechanical and Piping			20%				$1,349,699
Electrical, Instrumentation, and Controls			20%				$1,349,699
SUBTOTAL							**$10,797,592**
Tax on Materials			0%				$0

Contractor's Markup on Sub-Contractors' Work	10%	$609,650
Contractor's Overhead and Profit, Mob/Demob	15%	$1,620,000
Contractor's General Conditions	20%	$2,160,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST		**$15,190,000**
Project Contingency	40%	**$6,076,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs	25%	**$3,800,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST		**$25,070,000**

PROJECT: Bend Regional Resource Recovery Project
OWNER: City of Bend
LOCATION: Bend, OR
WYA Project #: 1007-50-22-01
PROJECT ELEMENT: Alternative 7
Organics Only Digestion at Knott Landfill and Hauled Digestate to Bend WWTP
Capital Costs

OPPC PROVIDED BY: AAR, WLS
OPPC PREPARATION DATE: 7/1/2022
REVIEWED BY: GKC, PLV

DESCRIPTION	MATERIAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST	INSTALL UNIT COST	INSTALL COST	TOTAL COST
Receiving Station							
Grinder	2	EA	$42,200	$84,400	$10,600	$21,200	105,600
Receiving Tank	2	EA	$104,150	$208,300	$26,000	$52,000	260,300
Insulation and heat tracing	2	EA	$17,320	$34,640	$4,300	$8,600	43,240
Mixing pumps	2	EA	$39,735	$79,470	$9,900	$19,800	99,270
Digester feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Digestion							
Digester tank and mixing system	1	EA	$969,000	$969,000	$242,250	$242,250	1,211,250
Digester heating system	1	EA	$82,625	$82,625	$25,000	$25,000	107,625
Biogas Processing							
Waste gas flare	1	EA	$60,000	$60,000	$15,000	$15,000	75,000
Gas conditioning/treatment system	1	EA	$200,000	$200,000	$50,000	$50,000	250,000
CNG system	1	EA	$1,200,000	$1,200,000	$300,000	$300,000	1,500,000
Solids Processing							
Dewatering feed pumps	2	EA	$37,500	$75,000	$9,400	$18,800	93,800
Asphalt pavement	125,000	SF	$2	$250,000	$1	$125,000	375,000
SUBTOTAL							**$4,214,885**
Site Fencing, Paving, Grading, and Yard Piping			20%				$842,977
Mechanical and Piping			20%				$842,977
Electrical, Instrumentation, and Controls			20%				$842,977
SUBTOTAL							**$6,743,816**
Tax on Materials			0%				$0
Contractor's Markup on Sub-Contractors' Work			10%				$383,641
Contractor's Overhead and Profit, Mob/Demob			15%				$1,012,000
Contractor's General Conditions			20%				$1,349,000
ENGINEER'S PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST							**$9,490,000**
Project Contingency			40%				**$3,796,000**
Engineering Design, Environmental Planning and Studies, Construction Management, ESDC, and Legal and Admin Costs			25%				**$2,370,000**
ENGINEER'S PRELIMINARY OPINION OF PROBABLE TOTAL CAPITAL COST							**$15,660,000**

Appendix F: O&M Costs

Alternative 1
Current Hauling and Reuse Practices
Operating Costs

Solids Products						
Compost generation revenue	0	wet tons/year	35	$/wet ton		$ - /year
Power						
Power generation revenue	0	kW	0	hours/week	0 kWh/week	$ - /year
Natural Gas						
CNG generation revenue	0.0	cfm	0	cf/day	0 cf/year	$ - /year
Summary						
					TOTAL	$ - /year

Alternative 2

Organics Only Digestion with Microturbine at Knott Landfill

Operating Costs

Digestion								
Power								
Grinder	2.2	kW	40	hours/week	89	kWh/week	$ 265	/year
Receiving tank mixing system	11.2	kW	40	hours/week	447	kWh/week	$ 1,326	/year
Digester feed pumps	0.4	kW	40	hours/week	17	kWh/week	$ 50	/year
Feedstock preheating (provided by recovered heat from microturbine)							$ -	/year
Digester heating (provided by recovered heat from microturbine)							$ -	/year
Digester mixing	19	kW	168	hours/week	3,108	kWh/week	$ 9,212	/year
Labor								
Daily Maintenance			2	hours/day			$ 23,995.16	/year
Dewatering								
Power								
Dewatering feed pumps	0.4	kW	40	hours/week	17	kWh/week	$ 50	/year
Centrifuge	30	kW	40	hours/week	1,200	kWh/week	$ 3,557	/year
Chemical								
Polymer	39	active lbs/dry	275	dry tons/year	$ 3.69	/dry ton	$ 39,591	/year
Labor								
Daily operations and maintenance			2	hours/day			$ 23,995	/year
Monthly maintenance			8	hours/month			$ 369	/year
Spare Parts								
Spare parts							$ 22,100	/year
Composting								
Power								
Blowers	2.00	kWh/ton (8 w	362.00	tons/week	4,706	kWh/year	$ 268	/year
Labor								
Material Movement	10.00	hr/wk			520	hr/year	$ 23,995	/year
Control System Operator	5.00	hr/wk			260	hr/year	$ 11,998	/year
Other								
Maintenance Costs							$ 18,600	/year
Microturbine								
Power								
Gas conditioning system	88.30	kW	151	hours/week	13,351	kWh/week	$ 39,572	/year
Labor								
Annual microturbine maintenance	$ 0.02	/kWh	205	kW	30,996	kWh/week	$ 32,236	/year
Annual gas conditioning system maintenance							$ 6,000	/year
Spare Parts/Media								
H2S media replacement	$ 26,000.00	three times per year					$ 78,000	/year
Siloxane/VOC media replacement	$ 8,000.00	once per year					$ 8,000	/year
Recycled Water								
Power								
Power use					2106	kWh/week	$ 6,242	/year
Labor								
Daily Maintenance			1	hours/day			$ 9,598	/year
Weekly Maintenance			3	hours/week			$ 5,537	/year
Monthly Maintenance			6	hours/month			$ 3,322	/year
Quarterly Maintenance			2	hours/quarter			$ 369	/year
Annual Maintenance			8	hours/year			$ 369	/year
Spare Parts								
			$ 2,500.00	/year			$ 2,500.00	/year
Equipment Consumables								

	$	525.00	/year		$	525.00 /year
Chemicals						
	$	592.75	/year		$	592.75 /year
Equipment Replacement						
	$	7,960.02	/year		$	7,960.02 /year
Avoided Cost of Agricycle Processing						
Avoided cost	$	166,000.00	/year		$	(166,000.00) /year
Summary						
				TOTAL	$	214,197 /year

Alternative 3

Organics Only Digestion with RNG at Knott Landfill

Operating Costs

Digestion		Rate		Annual Cost
Power				
Grinder	2.2 kW	40 hours/week	89 kWh/week	$ 265 /year
Receiving tank mixing system	11.2 kW	40 hours/week	447 kWh/week	$ 1,326 /year
Digester feed pumps	0.4 kW	40 hours/week	17 kWh/week	$ 50 /year
Feedstock preheating	0.16 MMbtu/hr	168 hours/week	26 MMbtu/week	$ 7,701 /year
Digester heating	0.05 MMbtu/hr	168 hours/week	8 MMbtu/week	$ 2,383 /year
Digester mixing	19 kW	168 hours/week	3,108 kWh/week	$ 9,212 /year
Labor				
Daily Maintenance	2 hours/day			$ 23,995 /year
Dewatering				
Power				
Dewatering feed pumps	0.4 kW	40 hours/week	17 kWh/week	$ 50 /year
Centrifuge	30 kW	40 hours/week	1,200 kWh/week	$ 3,557 /year
Chemical				
Polymer	39 active lbs/dry ton	275 dry tons/year	$ 3.69 /dry ton	$ 39,591 /year
Labor				
Daily operations and maintenance		2 hours/day		$ 23,995 /year
Monthly maintenance		8 hours/month		$ 369 /year
Spare Parts				
Spare parts				$ 21,900 /year
Composting				
Power				
Blowers	2.00 kWh/ton (8 week proc	362.00 tons/8week	4706 kWh/year	$ 268 /year
Labor				
Material Movement	10.00 hr/wk		520 hr/year	$ 23,995 /year
Control System Operator	5.00 hr/wk		260 hr/year	$ 11,998 /year
Other				
Maintenance Costs				$ 18,600 /year
CNG Production				TOTAL
Power				
Gas conditioning/treatment and compression	118.3 kW	168 hours/week	19874 kWh/week	$ 58,908 /year
Labor				
Annual BioCNG operations and maintenance	$ 0.44 /GGE	373 GGE/day	1,148 GGE/week	$ 26,265 /year
Annual gas conditioning system operations maintenance				$ 6,000 /year
Spare Parts				
H2S media replacement	$ 26,000.00 three times per year			$ 78,000 /year
Siloxane/VOC media replacement	$ 8,000.00 once per year			$ 8,000 /year
Recycled Water				TOTAL
Power				
Power use			2105.95 kWh/week	$ 6,242 /year
Labor				
Daily Maintenance		1 hours/day		$ 9,598 /year
Weekly Maintenance		3 hours/week		$ 5,537 /year
Monthly Maintenance		6 hours/month		$ 3,322 /year
Quarterly Maintenance		2 hours/quarter		$ 369 /year
Annual Maintenance		8 hours/year		$ 369 /year
Spare Parts				
		$ 2,500.00 /year		$ 2,500 /year
Equipment Consumables				
		$ 525.00 /year		$ 525 /year
Chemicals				
		$ 592.75 /year		$ 593 /year
Equipment Replacement				
		$ 7,960.02 /year		$ 7,960 /year

Avoided Cost of Agricycle Processing					
Avoided cost	$ 166,000.00	/year		$ (166,000.00)	/year
Summary				TOTAL	
			TOTAL	$ 237,445	/year

Alternative 4

Co-Digestion of WAS, FOG, Food, and Brewery Waste with Cogeneration at Bend WWTP

Operating Costs

Digestion								
Power								
Grinder	2.2	kW	40	hours/week	89	kWh/week	$ 265	/year
Receiving tank mixing system	11.2	kW	40	hours/week	447	kWh/week	$ 1,326	/year
Digester feed pumps	0.5	kW	40	hours/week	20	kWh/week	$ 58	/year
Feedstock preheating	3,836,066	btu/day			27	MMbtu/week	$ 7,808	/year
Digester heating	0.5	btu/hr/gal	425,000	gallons	36	MMbtu/week	$ 10,380	/year
Digester mixing	12.7	kW	168	hours/week	2,130	kWh/week	$ 6,312	/year
Labor								
Daily Maintenance	2	hours/day					$ 23,995	/year
Dewatering								
Power								
Dewatering feed pumps	0.7	kW	40	hours/week	28	kWh/week	$ 82	/year
Centrifuge	52	kWh/dry ton	275	dry tons/year	14,300	kWh/year	$ 815.10	/year
Polymer								
Polymer	39	active lbs/dry ton	275	dry tons/year	$ 3.69	/dry ton	$ 39,591	/year
Labor								
Daily operations and maintenance			2	hours/day			$ 23,995	/year
Monthly maintenance			8	hours/month			$ 369	/year
Spare Parts								
Spare parts							$ 22,100	/year
Biosolids Management								
Solids drying operations	275	dry tons/year	68.40	$/dry ton			$ 18,810	/year
Cogeneration								
Natural Gas								
Supplementary natural gas	0	Mmbtu/hr						
Labor								
Annual Maintenance	$ 0.03	/kWh	816	kW	123,448	kWh/week	$ 167,667	/year
Gas conditioning/treatment								
Power								
Gas conditioning system	88.30	kW	168	hours/week	14,834	kWh/week	$ 43,969	/year
Labor								
Annual gas conditioning system maintenance							$ 6,000	/year
Spare Parts/Media								
H2S media replacement	$ 26,000.00	three times per year					$ 78,000	/year
Siloxane/VOC media replacement	$ 8,000.00	once per year					$ 8,000	/year
Avoided Cost of Agricycle Processing								
Avoided cost			$ 166,000.00	/year			$ (166,000.00)	/year
Summary								
						TOTAL	$ 293,544	/year

Alternative 5

Co-Digestion of WAS, FOG, Food, Brewery Waste, and Septage with Cogeneration at Bend WWTP

Operating Costs

Digestion									
Power									
Grinder	2.2	kW	40	hours/week	89	kWh/week	$	265	/year
Receiving tank mixing system	11.2	kW	40	hours/week	447	kWh/week	$	1,326	/year
Digester feed pumps	1.1	kW	40	hours/week	43	kWh/week	$	126	/year
Feedstock preheating (provided by recovered heat from cogeneration)							$	-	/year
Digester heating (provided by recovered heat from cogeneration)							$	-	/year
Digester mixing	18.8	kW	168	hours/week	3,157	kWh/week	$	9,357	/year
Labor									
Daily Maintenance	2	hours/day					$	23,995	/year
Dewatering									
Power									
Dewatering feed pumps	2.0	kW	40	hours/week	81	kWh/week	$	239	/year
Centrifuge	52	kWh/dry ton	401	dry tons/year	20,864	kWh/year	$	1,189	/year
Polymer									
Polymer	39	active lbs/dry ton	401	dry tons/year	$ 3.69	/dry ton	$	57,741	/year
Labor									
Daily operations and maintenance			2	hours/day			$	23,995	/year
Monthly maintenance			8	hours/month			$	369	/year
Spare Parts									
Spare parts							$	22,100	/year
Biosolids Management									
Solids drying operations	401	dry tons/year	68.40	$/dry ton			$	27,444	/year
Cogeneration									
Natural Gas									
Supplementary natural gas	0	Mmbtu/hr							
Labor									
Annual Maintenance	$ 0.03	/kWh	717	kW	108,410	kWh/week	$	147,242	/year
Gas conditioning/treatment									
Power									
Gas conditioning system	88.30	kW	168	hours/week	14,834	kWh/week	$	43,969	/year
Labor									
Annual gas conditioning system maintenance							$	6,000	/year
Spare Parts/Media									
H2S media replacement	$ 26,000.00	three times per year					$	78,000	/year
Siloxane/VOC media replacement	$ 8,000.00	once per year					$	8,000	/year
Avoided Cost of Agricycle Processing									
Avoided cost			$ 498,000.00	/year			$	(498,000.00)	/year
Summary									
						TOTAL	$	(46,641)	/year

Alternative 6

Organics Only Digestion with Microturbine at Redmond RV Dump

Operating Costs

Digestion								
Power								
Grinder	2.2	kW	40	hours/week	89	kWh/week	$ 265	/year
Receiving tank mixing system	11.2	kW	40	hours/week	447	kWh/week	$ 1,326	/year
Digester feed pumps	0.4	kW	40	hours/week	17	kWh/week	$ 50	/year
Feedstock preheating (provided by recovered heat from cogeneration)							$ -	/year
Digester heating (provided by recovered heat from cogeneration)							$ -	/year
Digester mixing	19	kW	168	hours/week	3,108	kWh/week	$ 9,212	/year
Labor								
Daily Maintenance			2	hours/day			$ 23,995.16	/year
Dewatering								
Power								
Dewatering feed pumps	0.4	kW	40	hours/week	17	kWh/week	$ 50	/year
Centrifuge	30	kW	40	hours/week	1,200	kWh/week	$ 3,557	/year
Chemical								
Polymer	39	active lbs/dry	275	dry tons/year	$ 3.69	/dry ton	$ 39,591	/year
Labor								
Daily operations and maintenance			2	hours/day			$ 23,995	/year
Monthly maintenance			8	hours/month			$ 369	/year
Spare Parts								
Spare parts							$ 22,100	/year
Composting								
Power								
Blowers	2	kWh/ton (8 w	362.00	tons/week	4706	kWh/year	$ 268	/year
Labor								
Material Movement	10	hr/wk			520	hr/year	$ 23,995	/year
Control System Operator	5	hr/wk			260	hr/year	$ 11,998	/year
Other								
Maintenance Costs							$ 18,600	/year
Microturbine								
Power								
Gas conditioning system	88	kW	151	hours/week	13,351	kWh/week	$ 39,572	/year
Labor								
Annual microturbine maintenance	$ 0.02	/kWh	205	kW	30,996	kWh/week	$ 32,236	/year
Annual gas conditioning system maintenance							$ 6,000	/year
Spare Parts/Media								
H2S media replacement	$ 26,000	three times per year					$ 78,000	/year
Siloxane/VOC media replacement	$ 8,000	once per year					$ 8,000	/year
Recycled Water								
Power								
Power use					2106	kWh/week	$ 6,242	/year
Labor								
Daily Maintenance			1	hours/day			$ 9,598	/year
Weekly Maintenance			3	hours/week			$ 5,537	/year
Monthly Maintenance			6	hours/month			$ 3,322	/year
Quarterly Maintenance			2	hours/quarter			$ 369	/year
Annual Maintenance			8	hours/year			$ 369	/year
Spare Parts								
			$ 2,500.00	/year			$ 2,500	/year
Equipment Consumables								

	$	525.00	/year	$	525	/year
Chemicals						
	$	592.75	/year	$	593	/year
Equipment Replacement						
	$	7,960.02	/year	$	7,960	/year
Avoided Cost of Agricycle Processing						
Avoided cost	$	166,000.00	/year	$	(166,000.00)	/year
Summary						
			TOTAL	$	214,197	/year

Alternative 7
Organics Only Digestion at Knott Landfill and Hauled Digestate to Bend WWTP
Operating Costs

Digestion										
Power										
Grinder		2.2	kW	40	hours/week	89	kWh/week	$	265	/year
Receiving tank mixing system		11.2	kW	40	hours/week	447	kWh/week	$	1,326	/year
Digester feed pumps		0.4	kW	40	hours/week	17	kWh/week	$	50	/year
Feedstock preheating (provided by recovered heat from microturbine)								$	-	/year
Digester heating (provided by recovered heat from microturbine)								$	-	/year
Digester mixing		19	kW	168	hours/week	3,108	kWh/week	$	9,212	/year
Labor										
Daily Maintenance				2	hours/day			$	23,995	/year
Hauling										
Hauling from Knott Landfill to Bend WWTP										
Hauled digestate (4,000 gallon trucks)		72	truckloads/mo	215	$/truckload			$	186,269	/year
Dewatering										
Power										
Dewatering feed pumps		0.4	kW	40	hours/week	17	kWh/week	$	50	/year
Centrifuge		30	kW	40	hours/week	1,200	kWh/week	$	3,557	/year
Chemical										
Polymer		39	active lbs/dry	275	dry tons/year $	3.69	/dry ton	$	39,591	/year
Labor										
Daily operations and maintenance				2	hours/day			$	23,995	/year
Monthly maintenance				8	hours/month			$	369	/year
Spare Parts										
Spare parts								$	22,100	/year
Biosolids Management										
Solids drying operations		275	dry tons/year	68.40	$/dry ton			$	18,810	/year
CNG Production										TOTAL
Power										
Gas conditioning/treatment and compression		118.3	kW	168	hours/week	19874	kWh/week	$	58,908	/year
Labor										
Annual BioCNG operations and maintenance	$	0.44	/GGE	373	GGE/day	1,148	GGE/week	$	26,265	/year
Annual gas conditioning system operations maintenance								$	6,000	/year
Spare Parts										
H2S media replacement	$	26,000.00	three times per year					$	78,000	/year
Siloxane/VOC media replacement	$	8,000.00	once per year					$	8,000	/year
Avoided Cost of Agricycle Processing										
Avoided cost			$	166,000.00	/year			$	(166,000.00)	/year
Summary										
							TOTAL	$	340,763	/year

Appendix G: Products

Alternatives Product Production and Product Value

	Alternative 1 - Lime Stabilization and Application	Alternative 2 - Cogen at Knott Landfill	Alternative 3 - CNG at Knott Landfill	Alternative 4 - Codigestion at WWTP	Alternative 5 - Codigestion with Septage at WWTP	Alternative 6 - Cogen at Redmond RV Dump Station	Alternative 7 - Cogen at Knott Landfill, Haul Digestate to WWTP
Solids Products							
Lime Stabilized Solids, wet tons/year	9,539	0	0	0	0	0	0
Compost Produced, wet tons/year at 50% solids	0	550	550	0	0	550	0
Compost Unit Price, $/wet ton	$ 35	$ 35	$ 35	$ 35	$ 35	$ 35	$ 35
Biosolids Produced, wet tons/year at 20% solids	0	0	0	1,376	2,006	0	1,376
Solids Products Revenue, $/year	$ -	$ 19,250	$ 19,250	$ -	$ -	$ 19,250	$ -
Gas Products by Feedstock							
FOG, scfm	0	29	29	29	29	29	29
Grease, scfm	0	2	2	2	2	2	2
Food Waste, scfm	0	7	7	7	7	7	7
Brewery Waste, scfm	0	26	26	26	26	26	26
Septage, scfm	0	0	0	0	6	0	0
WWTP Solids, scfm	0	0	0	105	105	0	0
Total Gas Production, scfm	0	64	64	170	176	64	64
Power Products							
Power Production, kWh/year	0	1,616,220	0	5,428,527	5,652,828	1,616,220	0
Unit Price, $/kWh	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
Power Revenue from Hauled Feedstocks, $/year	$ -	$ 92,125	$ -	$ 117,197	$ 128,714	$ 92,125	$ -
Power Revenue from WWTP Solids, $/year	$ -	$ -	$ -	$ 192,229	$ 193,497	$ -	$ -
Total Power Revenue, $/year	$ -	$ 92,125	$ -	$ 309,426	$ 322,211	$ 92,125	$ -
RNG Products							
RNG Production, Mmbtu/year	0	0	19,589	0	0	0	19,589
Unit Price, $/Mmbtu	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4
RNG Revenue, $/year	$ -	$ -	$ 78,867	$ -	$ -	$ -	$ 78,867
D5 RIN Value[(a)], $/RIN	$ 0.97	$ 0.97	$ 0.97	$ 0.97	$ 0.97	$ 0.97	$ 0.97
RIN Produced, RIN/year	0	0	229,197	0	0	0	229,197
RIN Sales, $/year	$ -	$ -	$ 222,321	$ -	$ -	$ -	$ 222,321
RIN Brokerage Fee, 10%	$ -	$ -	$ (22,232)	$ -	$ -	$ -	$ (22,232)
Total RNG Revenue	$ -	$ -	$ 278,956	$ -	$ -	$ -	$ 278,956
Recycled Water							
Recycled Water Production, gal/day	0	8,182	8,182	0	0	8,182	0
Total Products Revenue	**$ -**	**$ 111,375**	**$ 298,206**	**$ 309,426**	**$ 322,211**	**$ 111,375**	**$ 278,956**

Notes:

(a) Average weekly RIN value for period 2019-2022

Appendix H: TBL Results

Triple Bottom Line Analysis Results

Category	Weight	Score						
		Alternative 1 - Lime Stabilization and Application	Alternative 2 - Cogen at Knott Landfill	Alternative 3 - CNG at Knott Landfill	Alternative 4 - Codigestion at WWTP	Alternative 5 - Codigestion with Septage at WWTP	Alternative 6 - Cogen at Redmond RV Dump Station	Alternative 7 - Cogen at Knott Landfill, Haul Digestate to WWTP
Environmental								
Permitting Complexity	5.9%	4.0	3.0	2.0	3.0	3.0	5.0	1.5
Environmental Risk	8.0%	1.0	4.0	4.0	3.0	3.0	4.0	3.0
Greenhouse Gas Emissions	9.5%	3.0	4.0	4.0	4.0	4.0	4.0	4.0
Beneficial Use	8.1%	3.0	3.0	4.0	5.0	5.0	3.0	4.0
Potential for Facility Co-Location	6.4%	3.0	5.0	5.0	5.0	5.0	4.0	5.0
Subtotal	38%	1.0	1.4	1.5	1.5	1.5	1.5	1.4
Social								
Public Acceptance	4.6%	2.0	3.0	3.0	4.0	4.0	4.0	3.0
Odor Control	4.7%	5.0	2.0	2.0	5.0	5.0	5.0	2.0
Provides Educational Opportunities	3.4%	2.0	5.0	5.0	5.0	5.0	5.0	5.0
Social Equity	3.5%	5.0	5.0	5.0	5.0	5.0	2.0	5.0
Allows for Population Growth	4.5%	1.0	3.0	3.0	3.0	3.0	3.0	3.0
Develops Diverse Community Partnerships	3.1%	1.0	3.0	3.5	3.0	4.0	2.0	3.5
Subtotal	24%	0.7	0.8	0.8	1.0	1.0	0.9	0.8
Cost								
Costs - Capital, Life Cycle, and Hauling	11.7%	3.0	1.0	2.0	3.0	4.0	1.0	2.0
Revenue - Tipping Fees, Energy/RNG/Residuals	9.5%	2.0	2.5	3.5	3.0	5.0	2.5	3.0
Reliability and Resiliency	10.5%	2.0	3.0	3.0	4.0	4.0	3.0	3.0
Incentives	6.3%	1.0	4.0	3.0	4.0	4.0	4.0	3.0
Subtotal	38%	0.8	0.9	1.1	1.3	1.6	0.9	1.0
Total	100%	2.5	3.2	3.4	3.8	4.2	3.3	3.2